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DEEP-SEA OCEAN TRENCHES AND THEIR FAUNA

G. M. Beliaev

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Deep-Sea [1]Ocean Trenches and Their Fauna, G. M. Beliaev[2], Moscow: Nauka, 1989, 255 p., ISBN 5-02-005276-0.

The book cites data on the fauna in deep-sea trenches and demonstrates the conditions for existence in them of deep-sea organisms. It correlates information regarding all the biological research conducted by Soviet and foreign expeditions from 1875 to 1985. Complete lists are given of the animals (from Protozoa to fish) that are known from depths over 6 km, over 800 species with an indication of their habitat depth and geographical dissemination. The unique nature of the animal world in the trenches, the reasons for its originality, questions of the evolution and origin of the trench fauna, and data on its zoogeographical zoning are discussed.

The book is intended for experts in zoology, ecology, hydrobiology, oceanography, zoogeography, evolution, teachers and students.

37 Tables, 69 illustrations, 690 bibliographic entries.

Reviewers: A. P. Andriashev, Corresponding Member of the USSR Academy of Sciences
K. N. Nesis, Dr. of Biology

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[1] Translator's note: The author uses the Russian word for "deep-sea" and the English bibliographic entries use "deep-sea" in the majority of cases to refer to hadal zones. The author in his explanations on pp. 3-4 of the Russian original provides the distinctions between abyssal, hadal and ultra-abyssal. There are words in Russian for ultra-abyssal and hadal, but the author uses "deep-sea" in most of his text except for specific times when he uses the words "ultra-abyssal" or "hadal". I have therefore used "deep-sea" following the author's usage and have used "hadal" and "ultra-abyssal" when the terms are specifically stated in Russian. When the term "greatest depths" is used, I have translated this as "hadal".

[2] The Russian names of the fauna, where possible, have been transliterated to match the names of the person they were named after (e.g. Zenkevitch) and they were used in the transliteration of the Russian bibliography; the remaining Russian-English bibliography used transliterated Russian names per the US State Department transliteration outline. The author Beliaev does occur as Belyayev in the English bibliography.

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Translator was Mira S. Beerbaum of Petaluma, California, who is American Translators Association Certified for Russian into English translation. Translation was completed in June 2004. Peter Brueggeman arranged the translation into a format for binding into paper copies, which were then distributed to numerous marine science libraries internationally. Peter Brueggeman created this PDF from the paper master copy, doing OCR on the text and page rotations where needed.

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Глубоководные океанические желоба и их фауна. / Г.М. Беляев. М.: Наука, 1989. –255 с. – ISBN 5-02-005276-0.

В книге приведены данные по фауне глубоководных желобов и показаны условия существования в них глубоководных организмов. Обобщены сведения о всех биологических исследованиях, проведенных советскими и зарубежными экспедициями в 1875–1985 гг. Приведены полные списки животных (от простейших до рыб), известных с глубин более 6 км, – более 800 видов с указанием глубин их обитания и географического распространения. Обсуждаются уникальность животного мира желобов, причины его своеобразия, вопросы эволюции и происхождения фауны желобов, данные по их зоогеографическому районированию.

Для зоологов, экологов, гидробиологов, океанологов, зоогеографов, эволюционистов, преподавателей и студентов.

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PREFACE

The study of life in deep-sea trenches, i.e., at the maximum depths of the ocean that cover a 5-kilometer range, from 6 to 11 km, essentially began less than four decades ago. Before 1948, the question of the actual possibility of the existence of life at such depths was unresolved. Starting in 1948, research on the animal world in the greatest ocean depths began to develop very intensively. The greatest advances were made in the last quarter of a century in the development of equipment used for this research, and in addition to traditional methods of collecting deep-sea animals, basically new methods of studying them began to be applied.

Soviet expeditions had the greatest success in studying the fauna of deep-sea trenches, primarily on the research vessel Vityaz, that made regular studies in the Pacific and Indian Ocean trenches for over a quarter of a century starting in 1949. The year-round Danish expedition on the ship Galathea also made a major contribution to the study of life in the trenches. It made the first biological studies in five deep-sea trenches. American expeditions in the last decades have made great advances in studying life in the trenches on several research ships using the latest methods of deep-sea oceanography.

Academician Lev Aleksandrovich Zenkevitch was the creator and organizer of this trend of research in our country and the leader of a number of deep-sea expeditions on the vessels Vityaz and Akademik Kurchatov. Professor Anton Bruun was the organizer and leader of the expedition on Galathea.

It became clear back in 1954-1956 that the fauna in the deep ocean troughs was so unique that the depths over 6-7 km should be isolated into a special zone in the system of vertical biological zonality of the ocean and it was called ultra-abyssal [Zenkevitch et al., 1954, 1955] or hadal [Bruun, 1956a; Wolff, 1960]. The separation of this zone and its great originality were further substantiated as the result of the generalization of new data [Beliaev, 1966b, 1972; Wolff, 1970].

The existence of life at all depths of the ocean has been proven by now; there is no doubt about separating the trench depths into a special vertical zone of the ocean and it has been accepted by the overwhelming majority of researchers on life in the ocean depths.

The author of this monograph published the book Benthic Fauna of the Greatest Depths of the World Ocean in 1966 that correlated the information that had been accumulated by then regarding life in deep-sea trenches, the composition of the benthic population at depths over 6,000 m numbering slightly less than 300 species of multi-cellular animals, and drew conclusions about the laws governing the vertical and geographical dissemination of ultra-abyssal fauna, its origin and evolution. In a number of subsequent publications I correlated the data regarding the pelagic and bottom-dwelling fauna of the ultra-abyssal zone. I stated considerations about the age of the deep-sea fauna, including the fauna in the trenches and substantiated the zoogeographical status of the trenches as independent ultra-abyssal provinces, etc.

After the publication of the 1966 summary, Soviet and American expeditions also made biological studies in many trenches whose animal world had heretofore remained completely unstudied. The Vityaz made a special detailed study of the Kuril-Kamchatka trench, the American expedition PROA on the research vessel (R/V) Spencer F. Baird obtained thousands of photographs of the bottom of several trenches with the animals living on it or near it, and the American expeditions on the ship Thomas Washington obtained new data on life at the maximum depths of several trenches based on descents to the bottom of photo-controllable bait and the use of traps with bait.

Systematic processing of animals collected in the trenches previously and those newly obtained by expeditions by different countries continued intensively. Numerous new taxons of species and genus ranks were described, and in several cases, even new families. Underwater photographs revealed a new group of animals of an order or class [Lemche et al., 1976] whose representatives were already known from photographs from several areas of the World Ocean, but had not yet been in human hands. The number of available species analyses of multi-celled animals known from depths of over 6,000 m more than doubled and approaches 700. All the publications that contain this information are distributed among numerous Russian and foreign periodicals or individual collections; although processing of the animals collected in the trenches is still underway (and probably will continue for another decade). I believe that it is necessary to correlate and sum up the accumulated diverse information about life in the deep-sea trenches.

Consequently, it was the objective of the author of this book to combine the information regarding biological research conducted in deep-sea trenches by the expeditions of various countries and, if possible, to compile complete lists of the currently defined animal species that populate the trench depths, with an indication of the vertical and geographical dissemination of each species and the published sources upon which this information was based.

The objective set by the author also included, if possible, a correlation of all these data and detection of the features inherent to both the ultra-abyssal fauna as a whole, and the fauna of individual trenches, as well as the laws governing the distribution of the trench fauna.

The geologists link the concept of "deep-sea trench" not only with the depth, but also with the common nature of the origin of the corresponding geomorphological formations. The deep-sea trenches, therefore, sometimes include certain trenches from depths somewhat less than 6 km. I will not discuss these trenches and their population.

From the very beginning of isolation of the special ultra-abyssal or hadal zone, the transitional nature of the fauna in the 6,000-7,000 m level has been repeatedly noted between the fauna of the ocean floor abyssal depths and the trenches proper [Zenkevitch et al., 1955; Wolff, 1960, 1970; Beliaev, 1966b, 1972; et al]. To a certain measure, I have therefore conditionally limited the discussion of the deep-sea troughs and their fauna to the depths below the isobath 6,000 m. It is the depths over 6,000 m that are generally confined to the deep-sea trenches, and only as an exception individual drops of somewhat over 6,000 m are encountered in the deep-sea ocean floor troughs.

In the further discussion of the topics related to the vertical distribution of life in the ocean my basis was the system of vertical biological zonality developed by a team of authors from the USSR Academy of Science Institute of Oceanography that was published in 1959 (see [Beliaev et al., 1959; Vinogradova, 1969c). According to this system I am adopting the following divisions for the benthic fauna: sublittoral zone, depths from 0 to 200 m (transitional level between the sublittoral and bathyal from 200 to 500-1,000 m), bathyal zone from 500-1,000 to 3,000 m, abyssal zone 3,000-6,000 m (upper abyssal 3,000-4,500 m, lower 4,500-6,000 m), ultra-abyssal or hadal zone of depth over 6,000 m. These boundaries, as noted by the author of this system, are significantly conditional, and all the zones are interrelated by transitional levels whose range may vary in different regions of the ocean and for different taxonomic animal groups.

Appendix I gives information regarding the biological research conducted by different expeditions in deep-sea trenches, about the gathering of animals, filming of them on the bottom or observations of them made from underwater manned vessels.

Appendix II (Tables1-26) lists the animals of different taxonomic groups, from Protozoa to fish as defined from the deep-sea trenches. When any group of animals was known from depths over 6,000 m by only one or a few species, information about them was not included in the Appendix II lists, but were discussed in the text in the chapter regarding the taxonomic composition. The animal lists included not only already published definitions of species, but in a number of cases, also unpublished preliminary definitions that were kindly provided to me by specialists in various taxonomic groups of animals who are processing collections of the Soviet expeditions. The surnames of the authors of these definitions are indicated in the "Source" column of the Appendix II tables. I am sincerely grateful to all the individuals who provided me with this data.

During the many years of working on the study of the trench fauna and deep-sea fauna of the ocean in general, I repeatedly discussed many questions and consulted with my colleagues, mainly from the Institute of Oceanography and the Zoological Institute of the USSR Academy of Sciences: A. P. Andriashev, B. Ya. Vilenkin, N. G. and M. Ye. Vinogradov, G. B. Zevina, O. N. Zezina, A. V. Ivanov, V. M. Koltun, R. Ya. Levenstein, V. V. Leont'yeva, N. M. Litvinova, V. Ya. Lus, A. N. Mironov, L. I. Moskalev, K. N. Nesis, M. N. Sokolova, A. A. Shileyko, as well as T. Wolff (Zoological Museum, Copenhagen).

The work whose results are covered in this book began jointly with my teacher, L. A. Zenkevitch, who passed away long ago, and my colleague and friend, Ya. A.Birstein. I also remember with gratitude the deceased V. G. Bogorov and Ye. M. Kreps and their constant friendly interest in my work. I am extremely grateful to Ye. M. Kreps for support of my views on the role of hydrostatic pressure as an ecological factor, and for statement of his opinions on this topic in a letter whose excerpts I cite in the book.

Joint work on studying trench fauna during trips on Vityaz also links me to many of these individuals.

During preparation of the book for print, L. I. Moskalev, G. V. Agapova, A. V. Gebruk, D. L. Ivanov, O. Yu. Pchelin and A. V. Smirnov provided major assistance in preparing the maps, graphs and other illustrations, as well as the bibliography and refining the bibliographic data.

I am deeply grateful to all of the aforementioned individuals. Without the constant support and friendly assistance of many of them I would hardly have been able to complete preparation of this book for print.

Chapter 1.
DEEP-SEA TRENCHES AND THEIR CHARACTERISTIC ENVIRONMENTS

DISTRIBUTION OF TRENCHES IN THE OCEAN, THEIR DEPTHS AND ORIGIN

Depths of over 6,000 m are mainly confined to the deep-sea trenches, although individual depressions to depths 6-7 km, rarely to 7.5 km, are encountered in deep-sea troughs of all oceans except the North Arctic. Depressions deeper than 6,000 m are usually encountered in ocean troughs in the form of separated, small-sized spots, but sometimes they may occupy extensive spaces of the trough floor which is especially characteristic for the northwest trough of the Pacific Ocean. The total area of the regions with depths over 6 km is very small compared to the area occupied by the abyssal depths (3-6 km). The first are only slightly over 1.5% and the second about 76% of the area of the World Ocean.

There are currently 37 known deep-sea trenches, the majority of which (28) are located in the Pacific Ocean, forming its periphery, and a few in the Atlantic (5) and Indian (4) Oceans (Table 1, Figs. 1-12). According to the currently most accepted hypothesis of lithospheric plate tectonics, the development of marginal trenches located along the coastal continents or island curves is explained by the subduction of the ocean lithospheric plates on the boundaries of their collision with the neighboring plates (usually bearing continents). During submersion of the edge of one plate under the other a deep-sea trench is formed (see Fig. 16). All 9 of the deepest trenches with similar depths about 9-11 km are located in the western half of the Pacific Ocean.

Comparatively few trenches of another type, trench-fault, are also formed on the boundaries of the lithospheric plates, but usually at a great distance from the continents in the area of the rifts, i.e., zones linked to the formation of underwater mountain chains and spreading, separation towards the neighboring lithospheric plates as a result of elevation and eruption to the surface of the ocean bottom of substance of the upper layer of the Earth's mantle (asthenosphere). As a result of the nonuniformity of this process, cross chain faults are formed that in some cases result in the development of deep-sea trench-faults (for more detail about plate tectonics see, e.g.: [Menard, 1971; Shepard, 1973; Russian translation Shepard, 1976; Sorokhtin, 1974]). The trench-faults include the Pacific Ocean: Imperator, Mussau, Lira, Vityaz and Hjort; in the Indian Ocean: Vema, East Indian and Diamantina; in the Atlantic Ocean: Cayman and Romanche. All the other trenches are classified as marginal and mainly related to subduction processes. However, the structure of the trenches and the nature of their relief are severely complicated because of repeated secondary tectonic disruptions, the development of faults and shifts in them such as grabens, uplifts, lateral shifts, etc.

Table 1 gives a list of the deep-sea trenches and the main ocean troughs with an indication of their greatest depths, the biological studies made in them and the research vessels that performed this work. The numbers in Table 1 correspond to the numbers on the schematic map (see Fig. 1) which shows the location of the trenches and the greatest depths of the ocean troughs. The names of the trenches and troughs and their maximum depths are given per the map data [Atlantic

TABLE 1.
REGIONS OF THE WORLD OCEAN WITH DEPTHS OVER 6,000 m , COLLECTIONS MADE IN THEM OR OBSERVATIONS OF ANIMALS (COORDINATES AND DEPTHS OF STATIONS ARE GIVEN IN APPENDIX I)

No. in order	Trench or trough	Greatest depth, m	Range of depths from which benthic or bottom-dwelling animals were obtained or observed	Number of catches or observations	Research vessels, years of operation
1	2	3	4	5	6
		Pacific Ocean			
1.	Aleutian	7822	6296-7286	8T, 4B, 1B	Vityaz, 1955-1969 Thomas Washington, 1970
2.	Kuril-Kamchatka	9717	6080-9530	26T, 5B	Vityaz, 1949-1966
3.	Japan	8412	6156-7587	1L 11T, 1B 1T 1T, 3B	Challenger, 1875 Vityaz, 1954-1976 Riofu-Maru, 1981 Hakuho-Maru, 1981
4.	Izu-Bonin	9810	6770-9750	8T O-several submersions 2T	Vityaz, 1955-1975 Archimede, 1962, 1967
5.	Ryukyu (Nansei)	7790	6660-7450	3T, 3B	Vityaz, 1955, 1975
6.	Volcano	9156	6330-8540	4T, 1B	Vityaz, 1955, 1975
7.	Mariana	110022	6580-10910	9T, 3B O-1 Catches of amphipods on bait 1T	Vityaz, 1958, 1975** Trieste, 1960 Thomas Washington, 1975
8.	Yap	8850	7190-8720	3T	Vityaz, 1975
9.	Palau	8069	7000-8042	P-1 station 2T	Spencer F. Baird, 1962 Vityaz, 1975
10.	Philippine	10265	6100-10210	3T, 1B 9T, 6B 2B, catch on bait and filming of animals collected on bait (at several stations)	Galathea, 1951 Vityaz, 1973, 1975 Thomas Washington, 1975
11.	Banda (Weber)	7440	6250-7340	3T, 2B 2T, 2B	Galathea, 1951 Vityaz, 1973, 1975
12.	Imperator	7900	-	-	-
13.	Admiralty	6887	-	-	-
14.	Mussau	7208	-	-	-
15.	Lira	6881	-	-	-
16.	New Britain	8320	7057-8260	P-1 station	Spencer F. Baird, 1962
17.	Bougainville	9103	6920-9043	2T 3T P-1 station	Galathea, 1951 Vityaz, 1957 Spencer F. Baird, 1962
18.	Vityaz (East Melanesia)	6150	6135	1B	Vityaz, 1958
19.	San Cristobal	8487	-	-	-
20.	Santa Cruz (North New	9174	8712-8930	P-1 station	Spencer F. Baird,

	Hebrides)				1962
21.	New Hebrides	7633	6680-6830	1T P-1 station	Vityaz, 1958 Spencer F. Baird, 1962

TABLE 1 (continuation)

1	2	3	4	5	6
22.	Tonga	10882	6600-10687	1T	Albatross, 1899
				4T, 2B	Vityaz, 1957, 1970
23.	Kermadec	10047	6180-10015	6T	Galathea, 1952
				2T	Vityaz, 1958
24.	Sedros	6225	-	-	-
25.	Central American (Guatemala)	6489	-	-	-
26.	Peru	6601	6000-6364	1T	Vema, 1958
				2T, P-2 stations	Eltanin, 1962
				15 T, 2B, P-2 stations	Anton Bruun, 1965
				2T, 3B	Akademik Kurchatov, 1968
27.	Chile	8069	6010-7720	1B	Dmitriy Mendeleyev, 1972
				1T	Eltanin, 1962
				2T, 2B	Akademik Kurchatov, 1968
				Photographs of animals collected on bait (at 7 stations)	Thomas Washington, 1972
28.	Hjort	6727	6070-6650	3T, 2B	Dmitriy Mendeleyev, 1976
29.	Northwest trough	6987	6010-6340	3T, 7B	Vityaz, 1955-1968
				13T	Soyo-Maru, 1978-1980
				1T	Kayo-Maru
30.	Northeast trough	6741	6017-6282	2T, 1B	Vityaz, 1955, 1958
				3T, 2B	Thomas Washington, 1970
31.	Central trough	7600	6013-6400	1T, 1B	Vityaz, 1957, 1970
32.	East Mariana trough	6771	6040	1T	Vityaz, 1957
33.	West Mariana trough	6600	-	-	-
34.	Philippine trough	7559	-	-	-
Indian Ocean					
35.		7209	6433-7160	2T, 1B	Galathea, 1951
				4T, 2B	Vityaz, 1959, 1962
36.	Vema	6492	6160-6300	1T	Akademik Kurchatov, 1967
37.	East Indian	6335	-	-	-
38.	Diamantina	7102	-	-	-
39.	North Australian trough	6240	-	-	-
40.	West Australian trough	6500	-	-	-
41.	Australian-Antarctic trough	6089	-	-	-
42.	Madagascar trough	6400	-	-	-
Atlantic Ocean					
43.	Puerto Rico	8742	6000-8330	1T	Albatross-2, 1948
				1T	Vema, 1959
				1T, P1	Cheyn, 1962
				O-2 submersions	Archimede, 1964
				1T	Dmitriy Mendeleyev, 1969
				over 8T	John Elliott Pillsbury, 1969, 1970
				4T, 2B	Akademik Kurchatov, 1973

TABLE 1 (end)

1	2	3	4	5	6
44.	Cayman	7491	6000-6950	2T 5T, 5B 1T	John Elliott Pillsbury, 1967, 1975 Akademik Kurchatov, 1963
45.	Romanche	7856	6330-7600	P-1 station P-1 station 5T, 1B	Calypso, 1956 Cheyn, 1961 Akademik Kurchatov, 1967, 1972
46.	South Sandwich	8248	6052-8116	3T, P-3 stations 5T, 2B	Eltanin, 1963 Akademik Kurchatov, 1971
47.	South Orkney	7240***	-	-	-
48.	North American trough	6591	-	-	-
49.	Canaries trough	6750	6120	1B	Akademik Mstislav Keldysh, 1981
50.	Zeleniy Mys trough	7282	6035	1T	Princesse Alice, 1901
51.	Brazil trough	6537	-	-	-
52.	Argentina trough	6245	6079	1T	Vema, 1959
53.	Agulhas trough	6150	-	-	-
54.	Africa-Antarctic trough	6972	-	-	-
55.	South Antilles trough (Scotia Sea)	7756	5650-6070	1T	Akademik Kurchatov, 1971

*T - trawl lines, B - bottom grab, L - lead-line pipe test, O - bathyscaphe observations, P -bottom photographs with animals.

**Vityaz in 1957 also made two trawlings at depths about 9,000 and 10,920 m which produced rocky or muddy sediments, but no animals were caught [Birstein et al., 1958].

*** In February, 1968 the research vessel Ob' registered three times to the east of the South Orkney Islands depths 7,200, 7,240 and 6320 m [Vaygachev, 1968]. Successful trawling was conducted in the South Orkney trench deeper than 6,000 m in March 1989 by the research vessel Dmitriy Mendeleyev.

Ocean 1:20 million, 1974; Pacific Ocean 1:25 million, 1976; bathymetric map of the World Ocean 1:40 million, 1977; Indian Ocean 1:15 million, 1979] and publications [Vaygachev, 1968; Mikhaylov, 1970; Faleyev et al, 1977; Leont'yeva, 1985]. Data on the catches of benthic animals are given for Soviet expeditions based on initial materials and for the other expeditions the sources are indicated in Appendix I..

Figures 2-12 show the contours of the majority of the trenches at the isobath 6,000 m (mainly per the World Ocean map of scale 1:10 million [GEBCO, 1984]; the eastern part of the Cayman trench is missing on this map and is given approximately per the smaller-scale maps; Hjort trench per [Zhivago, 1978]. These same figures show the stations at which biological work was performed.

Figure 1. Distribution of Depths over 6 km in the World Ocean
The numbers correspond to the trenches and troughs in Table 1.

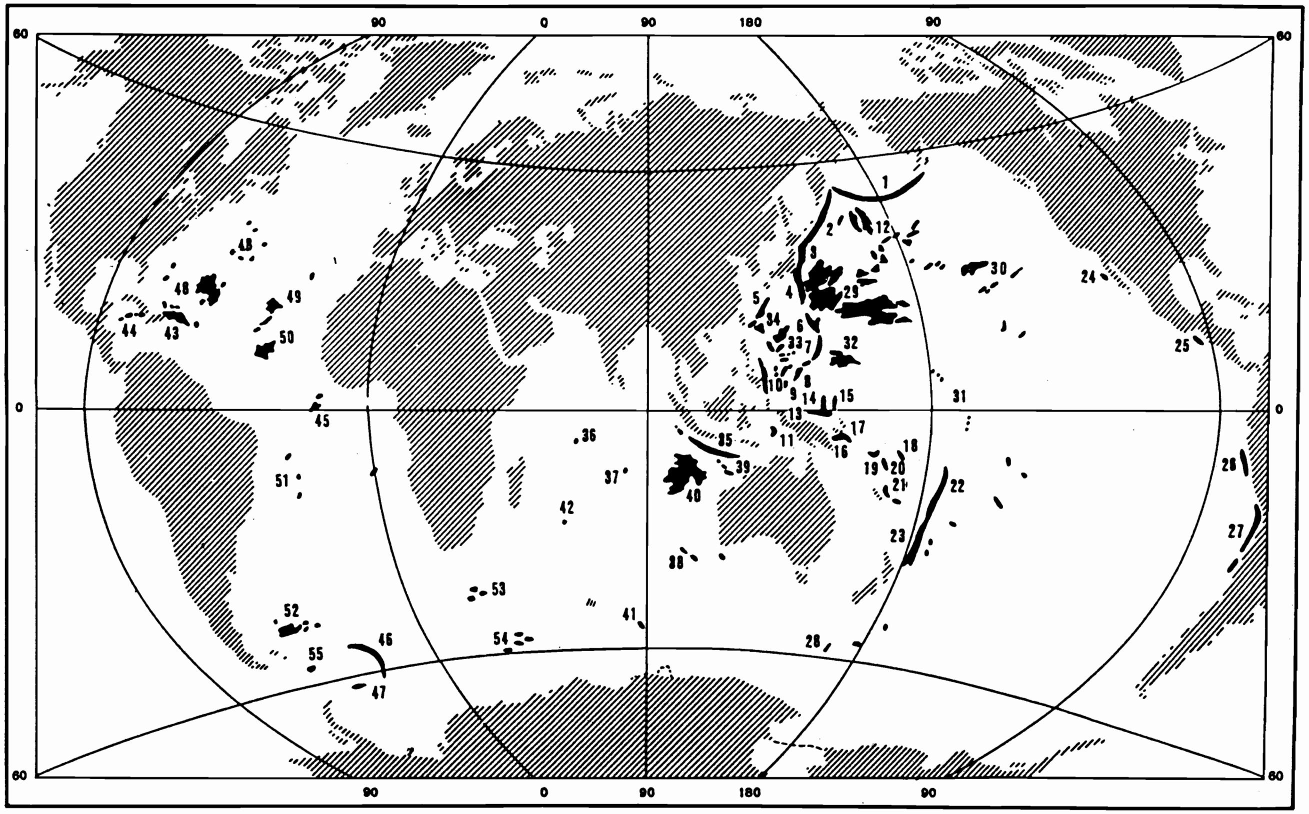

Рис. 1. Распространение глубин более 6 км в Мировом океане
Номера соответствуют желобам и котловинам в табл. 1

Figure 2. Aleutian Trench

Key:

Conventional designations of the research vessels whose stations are indicated in Figs. 2-12:

1. Vityaz
2. Akademik Kurchatov
3. Dmitriy Mendeleyev
4. Akademik Mstislav Keldysh
5. Galathea
6. Challenger
7. Princesse Alice
8. Albatross
9. Calypso
10. Trieste bathyscaphe
11. Archimede bathyscaphe
12. underwater research vessel Nautilus
13. Albatross
14. Vema
15. Spencer F. Baird
16. Eltanin
17. Chain
18. Anton Bruun
19. John Elliott Pilsbury
20. Thomas Washington
21. Gillis
22. Riofu-Maru
23. Soyo-Maru
24. Hakuho-Maru
25. Kayo-Ivru

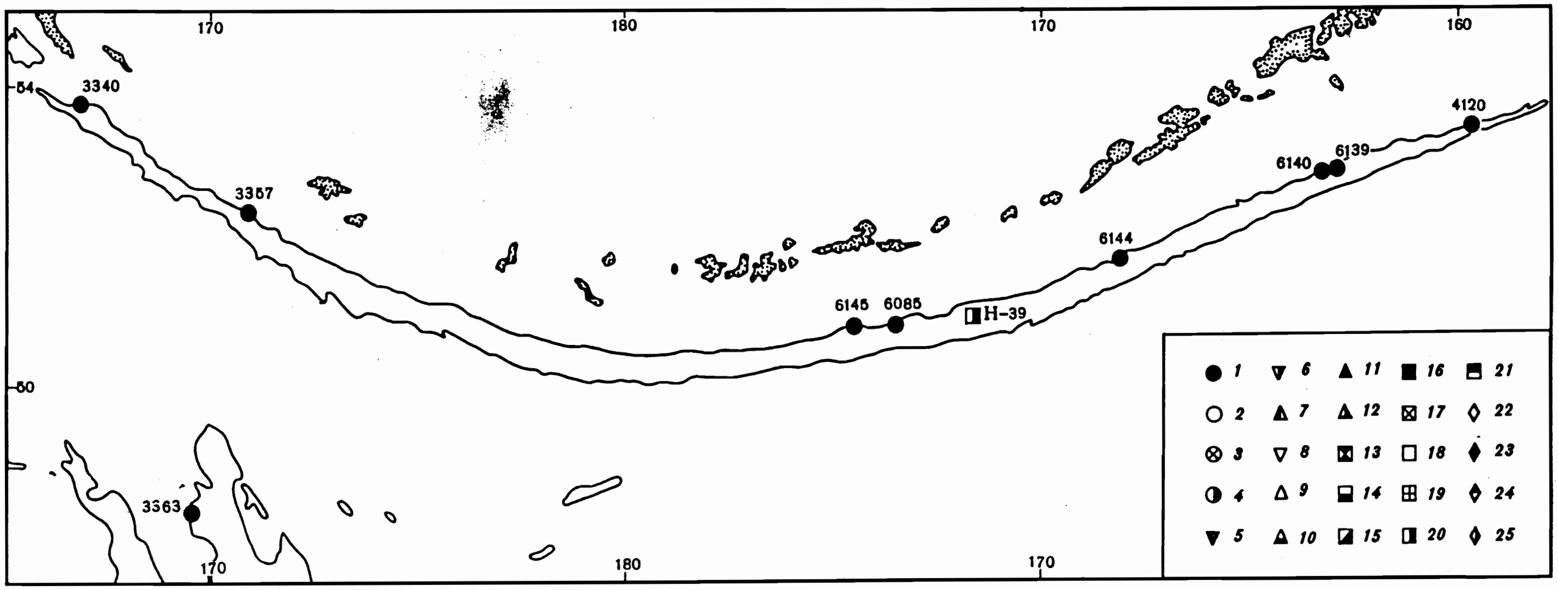

Рис. 2. Алеутский желоб

Условные обозначения экспедиционных судов, станции которых показаны на рис. 2–12: *1* – "Витязь"; *2* – "Академик Курчатов"; *3* – "Дмитрий Менделеев"; *4* – "Академик Мстислав Келдыш"; *5* – "Галатея"; *6* – "Челленджер"; *7* – "Принцесса Алиса"; *8* – "Альбатрос-2; *9* – "Калипсо"; *10* – батискаф "Триест"; *11* – батискаф "Архимед"; *12* – подводное исследовательское судно "Наутилус"; *13* – "Альбатрос"; *14* – "Вима"; *15* – "Спенсер Ф. Бэрд"; *16* – "Илтенин"; *17* – "Чейн"; *18* – "Антон Бруун"; *19* – "Джон Эллиотт Пилсбари"; *20* – "Томас Вашингтон"; *21* – "Джиллис"; *22* – "Риофу-Мару"; *23* – "Сойо-Мару"; *24* – "Хакухо-Мару"; *25* – "Кайо-Иару"

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Figure 3. Kuril-Kamchatka Trench

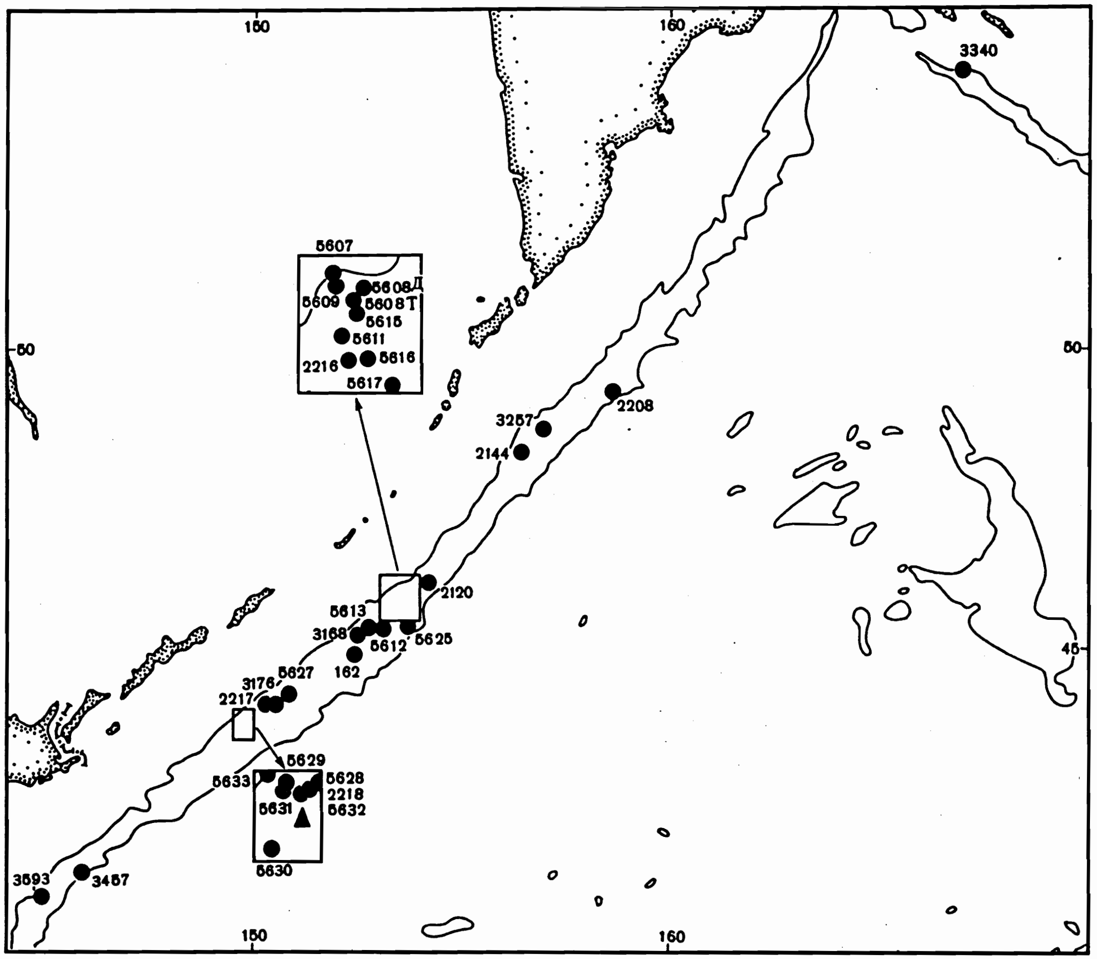

Рис. 3. Курило-Камчатский желоб

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Figure 4. Japan and Izu-Bonin Trenches and
Northwest Trough of the Pacific Ocean

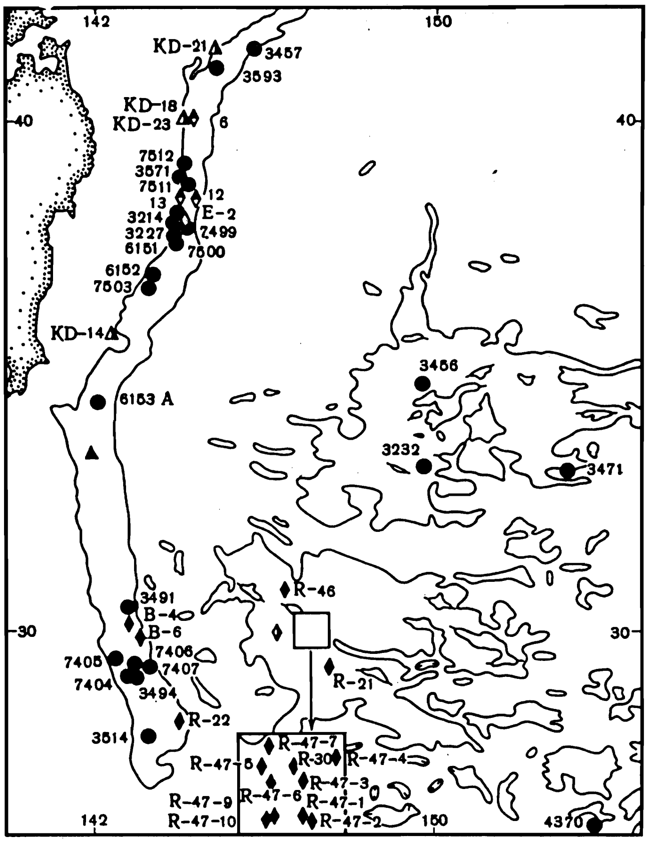

Рис. 4. Японский и Идзу-Бонинский желоба и Северо-западная котловина Тихого океана

УСЛОВИЯ ВНЕШНЕЙ СРЕДЫ

Условия, при которых обитают животные в глубоководных желобах, в некоторых отношениях весьма сходны с условиями на абиссальных глубинах, но наряду с этим характеризуются и рядом своеобразных черт, с одной стороны ограничивающих возможность существования в желобах многих животных (особенно на их наибольших глубинах), с другой – благоприятствующих более обильному количественному развитию жизни, чем на ложе океана.

ТЕМПЕРАТУРА

Температурные условия на глубинах более 6 км отличаются исключительной стабильностью. Судя по имеющимся данным, температура на глубинах от 6 до 11 км в разных желобах изменяется в пределах от –0,27 до +4,49° (табл. 2). Общий размах изменений температуры во всей ультраабиссальной зоне составляет, таким образом, менее 5°, причем он полностью укладывается в диапазон изменений температуры на абиссальных глубинах различных районов океана. Если же исключить желоба Банда и Кайман, выделяющиеся среди других желобов наиболее высокой температурой, и наиболее холодноводный субантарктический Южно-Сандвичев желоб с отрицательной температурой воды, то для всех остальных желобов диапазон изменений температуры составит лишь 2°. В пределах же отдельных желобов температура изменяется еще меньше, и на всех глубинах от 6 до 11 км ни в одном из желобов ее изменения не превышают 0,9°.

ENVIRONMENTAL CONDITIONS

The conditions under which animals live in deep-sea trenches, in certain respects are very similar to the conditions at abyssal depths, but they have additional features and a number of unique characteristics that, on the one hand, limit the possibile existence in the trenches for many animals (especially at the greatest depths), and on the other hand, are favorable to a more abundant quantitative development of life than on the ocean floor.

TEMPERATURE

The temperature conditions at depths over 6 km are exceptionally stable. Based on the available data, the temperature at depths from 6 to 11 km varies in different trenches from -0.27 to +4.49° (Table 2). The overall scope of temperature changes in the entire ultra-abyssal zone is thus less than 5° and it occurs completely in the range of temperature changes at the abyssal depths of various ocean regions. If we exclude the Banda and Cayman trenches that have the highest temperature among the other trenches, and the coldest sub-Antarctic South Sandwich trench with negative water temperature, then the temperature change range for the remaining trenches is only 2°. The temperature within individual trenches changes even less, and at all depths from 6 to 11 km, its changes do not exceed 0.9° in any of the trenches.

Figure 5. Ryukyu, Philippine, Palau, Yap, Mariana, Volcano Trenches, Philippine and East Mariana Trough

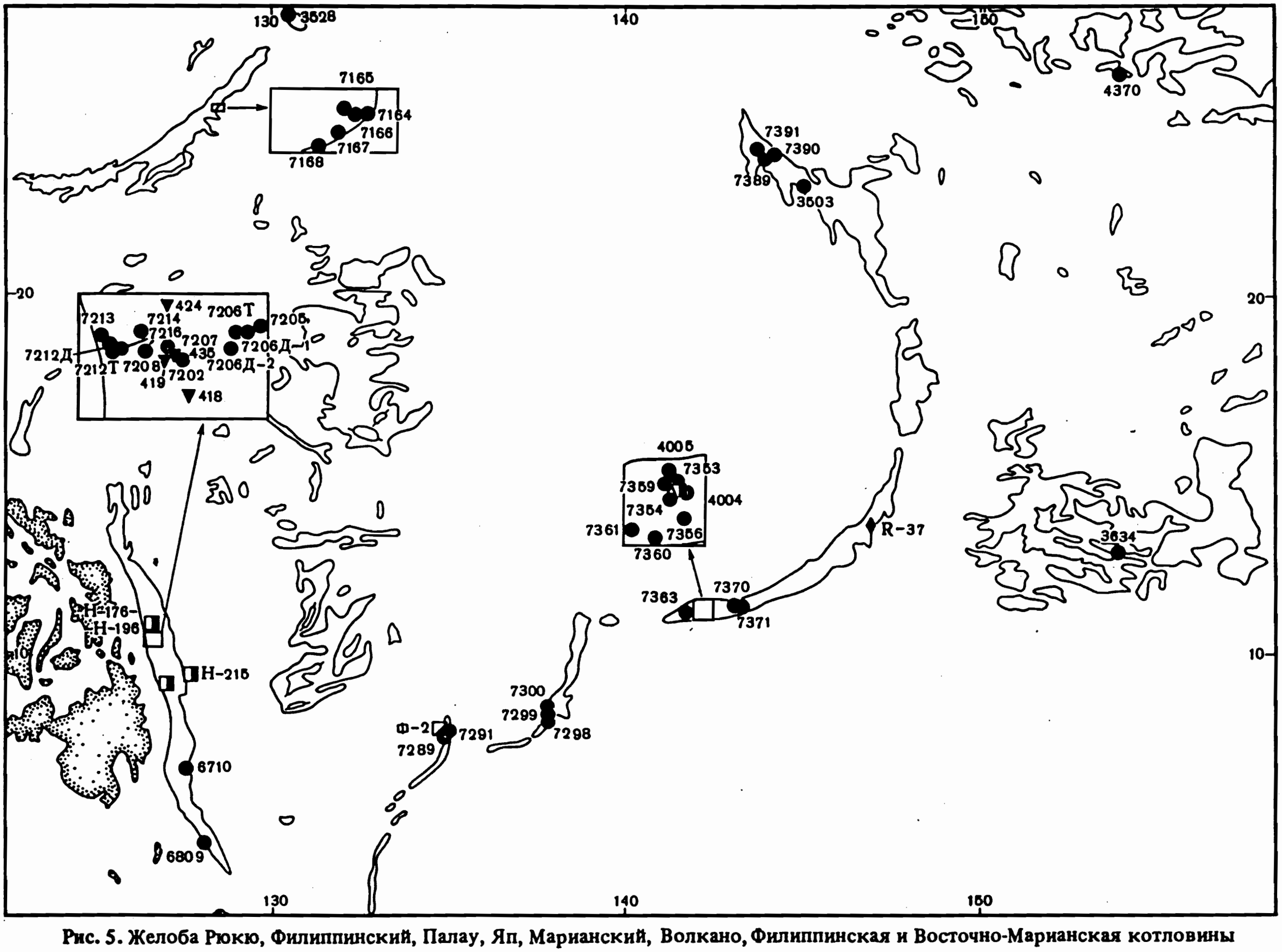

Рис. 5. Желоба Рюкю, Филиппинский, Палау, Яп, Марианский, Волкано, Филиппинская и Восточно-Марианская котловины

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Figure 6. New Britain, Bougainville, Santa Cruz, New Hebrides and Vityaz Trenches

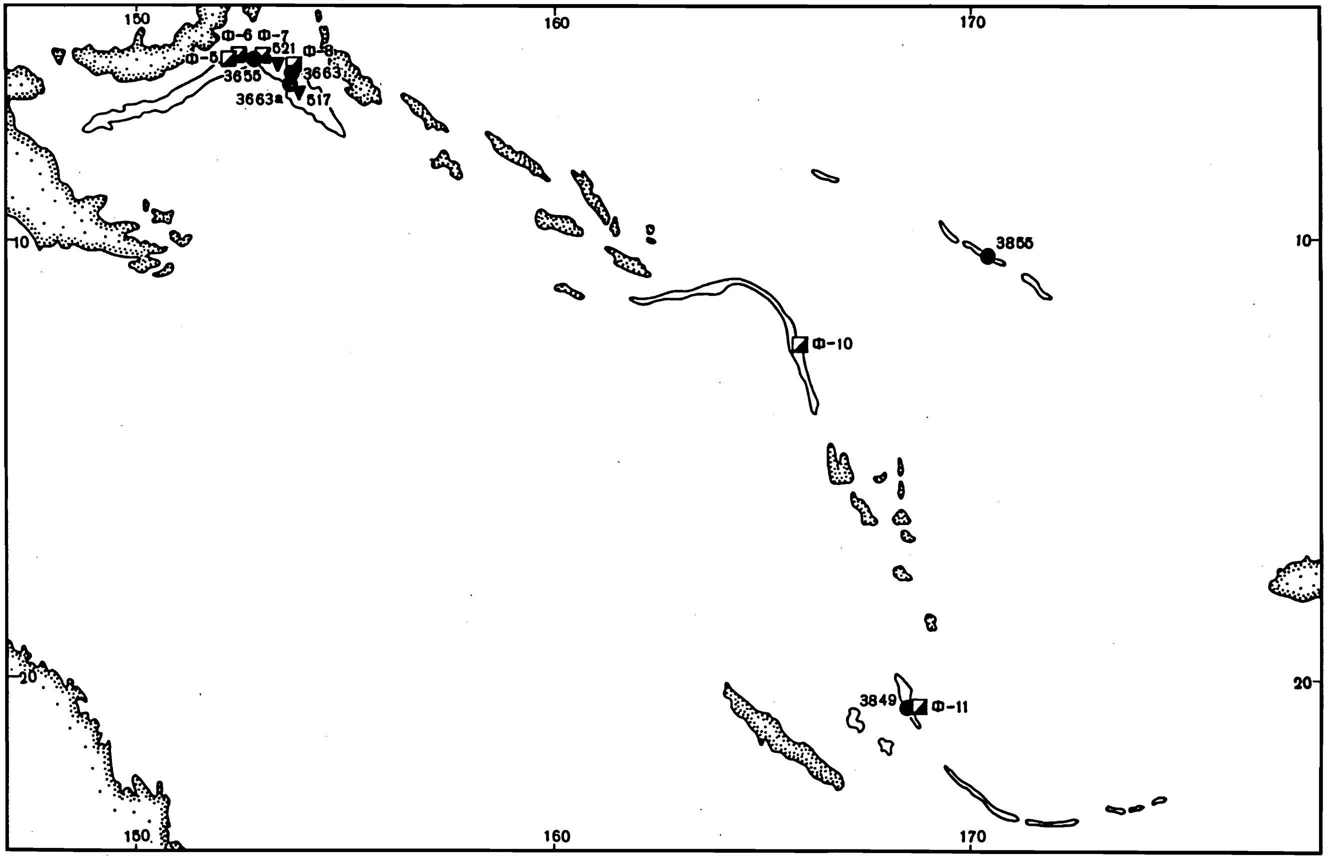

Рис. 6. Желоба Ново-Британский, Бугенвильский, Санта-Крус, Ново-Гебридский и Витязь

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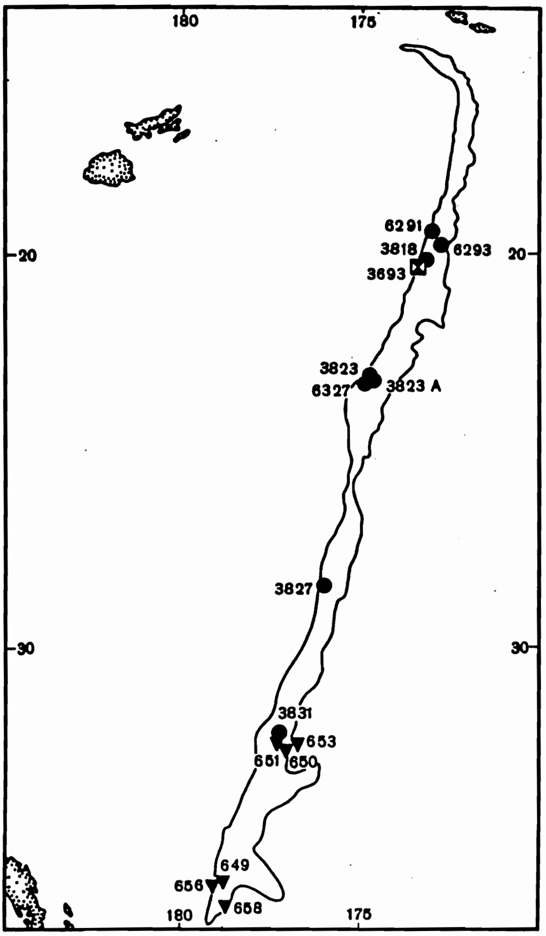
Figure 7. Tonga and Kermadec Trenches

Figure 8. Peru and Chile Trenches



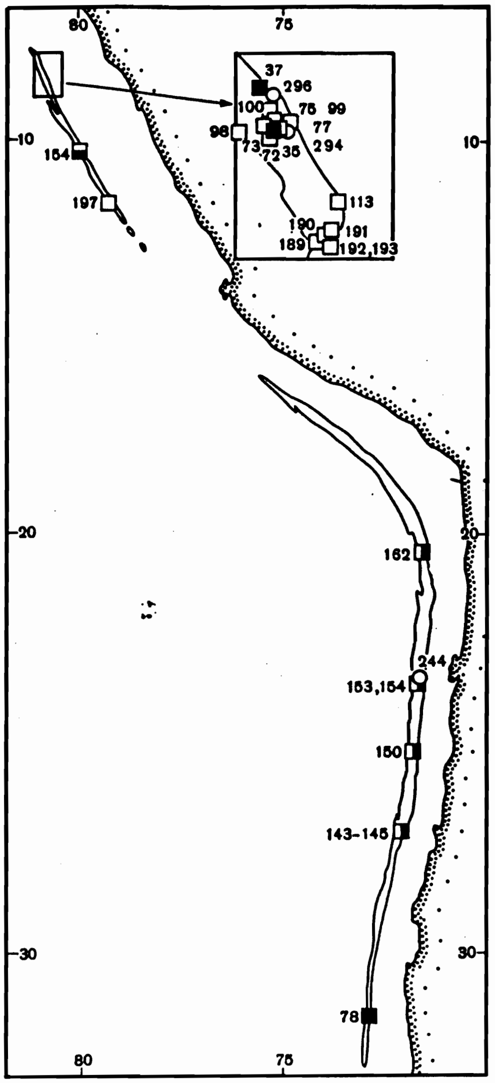


Рис. 7. Желоба Тонга и Кермадек

Рис. 8. Желоба Перуанский и Чилийский

Характерное для глубин более 6 км явление – постепенное повышение температуры по мере увеличения глубины, обусловленное увеличением давления (адиабатическое повышение температуры). Поэтому глубже 6 км температура воды всегда несколько выше, чем в абиссали того же района океана.

При сравнении температуры в разных желобах на сходных глубинах видно, что, кроме субантарктических желобов Южно-Сандвичева и Хьорт, наиболее холодноводными являются желоба Кермадек, Тонга и Яванский, что объясняется наибольшей доступностью этих желобов для проникновения в них холодных глубинных антарктических вод. Наиболее высокая температура свойственна желобам Кайман и Банда. Оба эти желоба отделены от открытых районов соответственно Атлантического или Индийского и Тихого океанов относительно мелководными проливами с глубинами, не превышающими глубин батиальной зоны. Поэтому в эти желоба не могут проникать холодные

Depths over 6 km have a characteristic feature of a gradual rise in temperature as the depth increases due to a rise in pressure (adiabatic temperature rise). Water temperature below 6 km is therefore always somewhat higher than in the abyssal of the same ocean region.

It is apparent from a comparison of the temperature in various trenches at similar depths that, except for the sub-Antarctic trenches of South Sandwich and Hjort, the coldest are the trenches of Kermadec, Tonga and Yavan due to the greatest accessibility of these trenches to the penetration of cold, deep Antarctic water. The highest temperature is inherent to the Cayman and Banda trenches. Both of these trenches are separated from open regions respectively of the Atlantic or Indian and Pacific Oceans versus the relatively shallow straits with depths below the bathyal zone. Cold deep water of Antarctic origin therefore cannot enter these trenches, and the sources of deepwater formation in these trenches are apparently limited to the local regions in which they are located. Due to the isolation of these trenches to the shallow thresholds from the open ocean abyssal zone, they may be called "pseudo-hadal" by analogy with the names "pseudo-bathyal" and "pseudo-abyssal" as understood by A. P. Andriashev [1979].

The Bougainville trench (and, apparently, other Coral Sea trenches) is characterized by somewhat higher temperature versus the other trenches, which is also probably explained by the relatively low accessibility of the Coral Sea basin to the deep waters of Antarctic origin [Leont'yeva, 1985].

Figure 9. Northwest (A), Northeast (B) and Central (C) Pacific Ocean Troughs

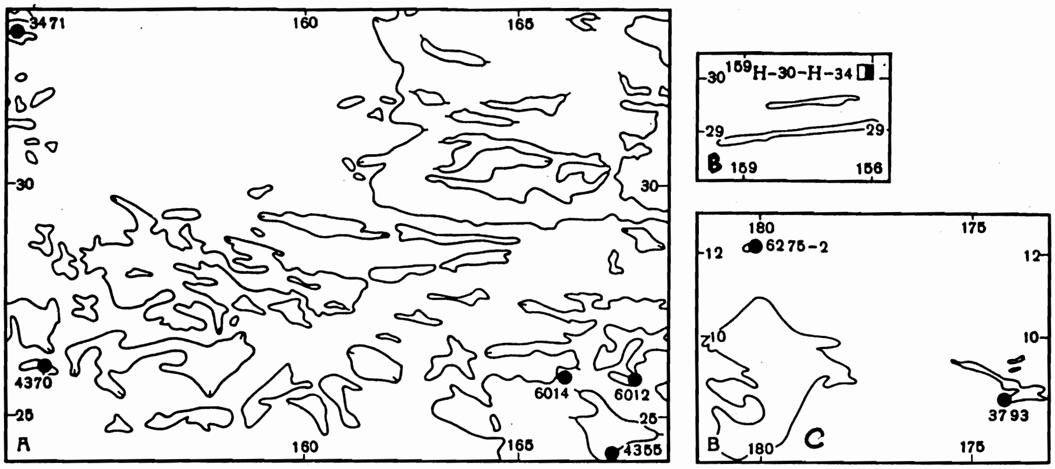


Рис. 9. Северо-западная (*А*), Северо-восточная (*Б*) и Центральная (*В*) котловины Тихого океана

глубинные воды антарктического происхождения и источники формирования глубинных вод этих желобов, видимо, ограничены локальными районами, в которых они расположены. Вследствие изоляции этих желобов мелководными порогами от открытой океанической абиссали к ним можно было бы применить название "псевдохадальные" по аналогии с названиями "псевдобатиаль" и "псевдоабиссаль" в понимании А.П. Андрияшева [1979].

Из других желобов несколько более высокой температурой характеризуется Бугенвильский желоб (и, видимо, другие желоба Кораллового моря), что, вероятно, также объясняется относительно малой доступностью бассейна Кораллового моря для глубинных вод антарктического происхождения [Леонтьева, 1985].

СОЛЕНОСТЬ

По многочисленным измерениям, проведенным во многих желобах (данные разных экспедиций суммированы в сводке [Леонтьева, 1985]), соленость на глубинах от 6 до 10 км практически не отличается от нормальной океанической. В подавляющем большинстве желобов она составляет около 34,7‰ с колебаниями от 34,64 до 34,81‰. Самая низкая соленость обнаружена в желобе Банда – от 34,58 до 34,67‰. Для желобов, расположенных в тропической Атлантике, характерно незначительное повышение солености по сравнению с другими желобами: в желобе Романш – от 34,67 до 34,96‰, в Пуэрто-Рико – 34,80–34,89‰ и наиболее высокая в желобе Кайман – 34,99–35,00‰. Как видно из этих цифр, изменения солености на всех глубинах ультраабиссали в большинстве желобов составляют менее 0,2‰, но даже с учетом крайних показателей в желобах с отличающейся соленостью они не превышают 0,42‰. Такие изменения солености не могут оказывать влияния на распространение даже наиболее стеногалинных морских организмов.

КИСЛОРОД

Содержание растворенного в воде кислорода на всех глубинах от 6 до 10 км подвержено значительным колебаниям в разных желобах и даже по измерениям, проведенным в разное время или в разных участках одного и того же желоба (данные разных экспедиций суммированы в сводке [Леонтьева, 1985]). Участков с дефицитом кислорода в придонном слое воды на ультраабиссальных глубинах до сих пор ни разу обнаружено не было. Наиболее высоким содержанием O_2 характеризуются субантарктические

SALINITY

Based on numerous measurements made in many trenches (the data from different expeditions are summarized in [Leont'yeva, 1985], the salinity at depths from 6 to 10 km essentially does not differ from the normal ocean levels. In the majority of the trenches, it is about 34.7 0/00, fluctuating from 34.64 to 34.81 0/00. The lowest salinity was found in the Banda trench, from 34.58 to 34.67 0/00. The trenches that are located in the tropical Atlantic are characterized by a slightly higher salinity versus the other trenches: in the Romanche trench from 34.67 to 34.96 0/00, in Puerto Rico 34.80-34.89 0/00, and the highest in the Cayman trench, 34.99-35.00 0/00. It is apparent from these numbers that salinity changes at all depths of the ultra-abyssal in the majority of the trenches are less than 0.2 0/00, but even taking into consideration the extreme indicators in the trenches with distinguishing salinity, they do not exceed 0.42 0/00. These salinity changes may not affect the dispersion of even the most stenohaline marine organisms.

OXYGEN

The content of oxygen dissolved in water at all depths from 6 to 10 km is subject to extreme fluctuations in various trenches and even based on measurements made in different seasons or in different sections of the same trench (the data from various expeditions are summarized in [Leont'yeva, 1985]. No sections have yet to be found with a shortage of oxygen in the benthic water layer at ultr-abyssal depths. The highest O_2 content is characteristic for the sub-Antarctic

Figure 10. Yavan and Banda (A), Vema (B) and Diamantina (C)

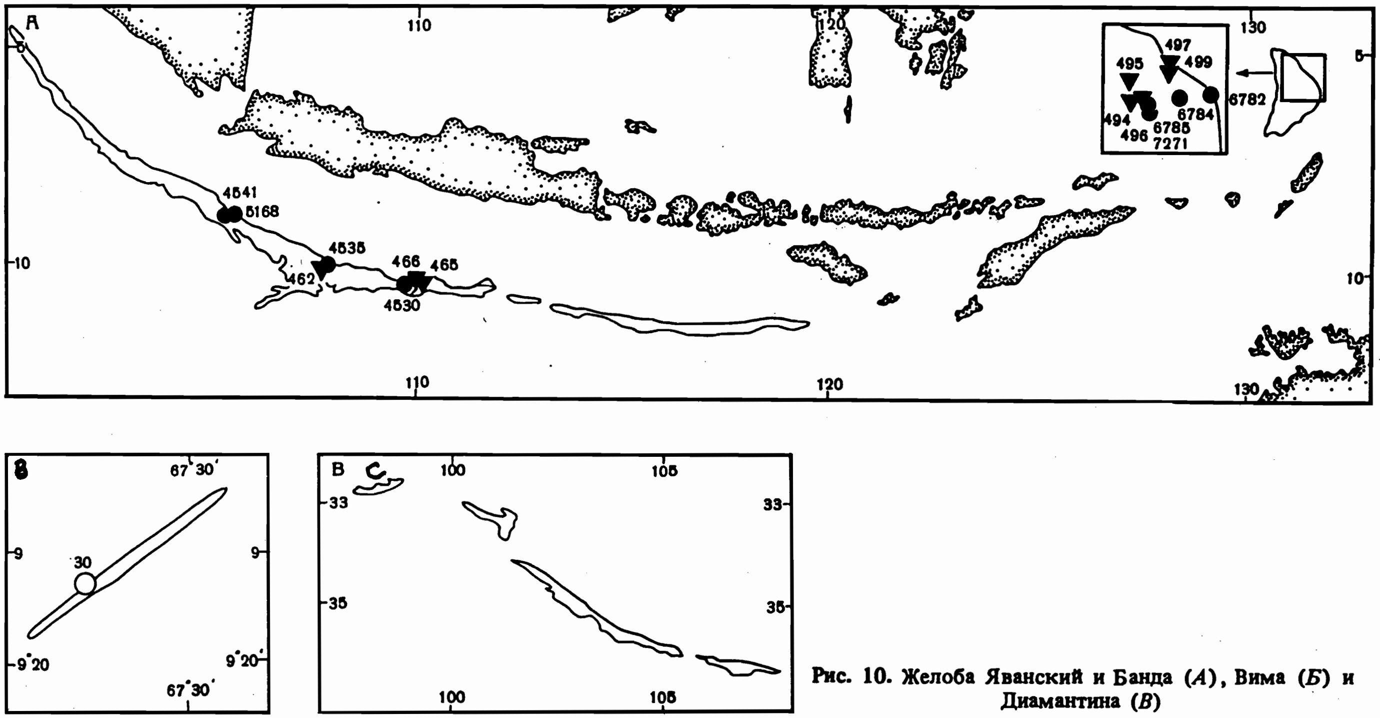


Рис. 10. Желоба Яванский и Банда (*А*), Вима (*Б*) и Диамантина (*В*)

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Figure 11. Sub-Antarctic Trenches of South Sandwich (A) and Hjort (B)

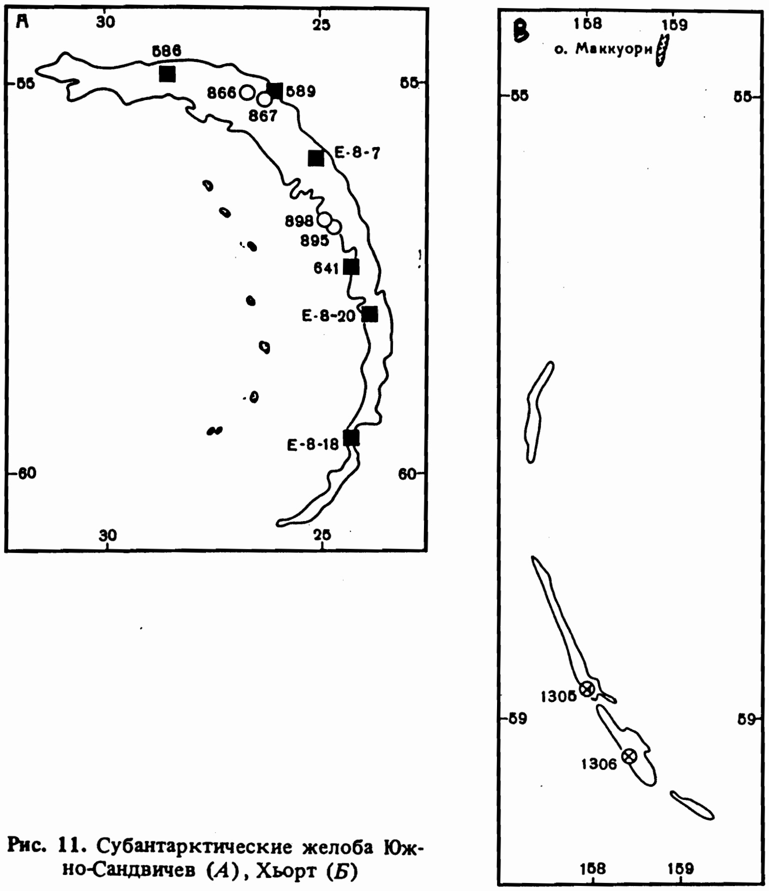

Рис. 11. Субантарктические желоба Южно-Сандвичев (*А*), Хьорт (*Б*)

желоба Южно-Сандвичев и Хьорт и желоба Кайман и Пуэрто-Рико – от 4,9 до 6,9 мл/л, или около 65–70% насыщения, и даже более. Лишь немногим меньшая концентрация O_2 обнаружена в желобах Кермадек, Тонга и Яванском – 4,0–4,7 мл/л, или около 55 –63% насыщения.

Самая низкая концентрация O_2 обнаружена в желобе Банда: по данным восьми измерений, проведенных в этом желобе глубже 6 км четырьмя экспедициями, концентрация O_2 была 2,03–2,38 мл/л, или 27–32%. Однако и этого количества кислорода оказывается достаточно для существования на дне желоба Банда фауны не менее обильной и разнообразной, чем во многих других желобах. Остальные желоба характеризуются промежуточными показателями. Однако колебания этих показателей, полученных в разных участках желоба, в разное время и на разных глубинах, могут быть выражены в различной степени. Так, например, в Филиппинском желобе по 25 измерениям, проведенным на пяти станциях экспедицией на "Галатее" [Kiilerich, 1964], и по 20 измерениям трех других экспедиций (см.: [Леонтьева, 1985]) концентрация O_2 составляла от 2,26 до 3,60 мл/л, или от 30 до 47% насыщения. Эти показатели для желобов Курило-Камчатского и Алеутского были соответственно 2,36–4,32 мл/л (31–56%) и 2,99–3,92 мл/л (39–51%). Сходные показатели были получены разными экспедициями и для Марианского желоба (3,07–4,42 мл/л). Для соседнего с ним желоба Палау "Витязем" в 1957 г. были получены близкие величины для глубин 6–8 км – 3,66–3,71 мл/л, или несколько меньше 50% насыщения. Однако спустя пять лет экспедицией на судне "Спенсер Ф. Бэрд" на тех же глубинах в этом желобе была обнаружена

trenches of South-Sandwich and Hjort, and the Cayman and Puerto Rico trenches from 4.9 to 6.9 ml/l or about 65-70% of saturation, and even more. A slightly lower O_2 concentration was detected in the trenches of Kermadec, Tonga and Yavan, 4.0-4.7 ml/l, or about 55-63% saturation.

The lowest O_2 concentration was found in the Banda trench: based on the data from eight measurements in this trench at a depth over 6 km by four expeditions, the O_2 concentration was 2.03-2.38 ml/l, or 27-32%. However, there was sufficient oxygen in this quantity for the existence on the floor of the Banda trench of no less abundant and diverse fauna than in many other trenches. The other trenches are characterized by intermediate indicators. However, the fluctuations in these indicators that were obtained in different trench sections, in different seasons and at various depths could be expressed to a varying degree. For example, in the Philippine trench, based on 25 measurements made at five stations by the Galathea expedition [Kiilerich, 1964] and 20 measurements of three other expeditions (see: [Leont'yeva, 1985], the O_2 concentration varied from 2.26 to 3.60 ml/l, or from 30 to 47% of saturation. These indicators for the Kuril-Kamchatka and Aleutian trenches were respectively 2.36-4.32 ml/l (31-56%) and 2.99-3.92 ml/l (39-51%). Similar indicators were obtained by various expeditions for the Mariana trench (3.07-4.42 ml/l) as well. For the neighboring Palau trench, Vityaz in 1957 obtained close levels for depths 6-8 km, 3.66-3.71 ml/l, or slightly lower than 50% saturation. However, five years later, the expedition on the vessel Spencer F. Baird at the same depths in this trough detected

Figure 12. Cayman and Puerto Rico Trenches (A) (expedition Chain: a--dredging, b--photograph), Romanche trench (B), C, D--troughs: Canaries, Zeleniy Mys (C), Argentine (D)

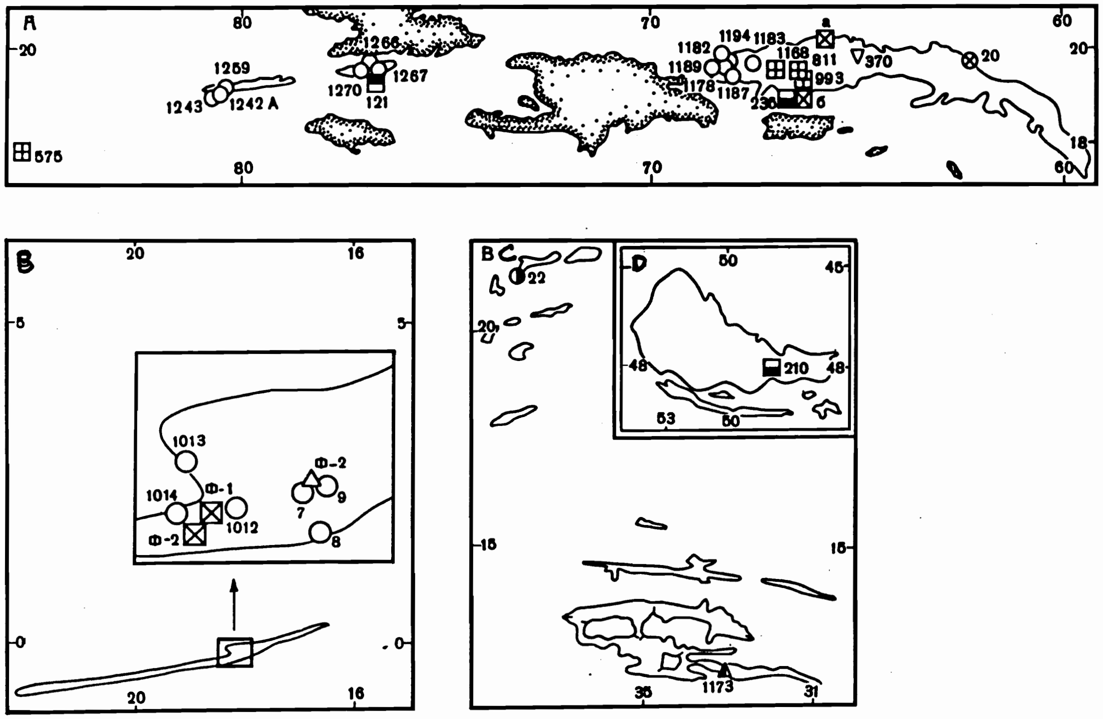

Рис. 12. Желоба Кайман и Пуэрто-Рико (*А*) (экспедиция "Чейн": *а* – драгировка, *б* – фото), желоб Романш (*Б*), *В*, *Г* – котловины: Канарская и Зеленого Мыса (*В*), Аргентинская (*Г*)

TABLE 2
WATER TEMPERATURE IN DEEP-SEA TRENCHES

Trench	Depth, m	Temperature, °C	Date	Research Vessel
Aleutian	6328	1.78	02/1958	Vityaz
Kuril-Kamchatka	6000-9000	1.65-2.15	06/1953	Vityaz
Japan	6000-6680	1.60-1.74	1954, 1961	Vityaz Riofu-Maru
Izu-Bonin	7305 9180	1.54 2.36	10/1955 08/1962	Vityaz Archimede Bathyscaphe
Northwest trough	6025	1.54	03/1959	Vityaz
Pacific Ocean Ryukyu	6660	1.84	10/1955	Vityaz
Philippine	6000-10,035 6000-9864	1.84-2.48 1.85-2.56	05/1930 07-08/1951	Snellius Galathea
Volcano	6080-7265	1.53-1.72	10/1955	Vityaz
Mariana	6000-8805 10,910	1.57-2.05 2.4	08/1957 01/1960	Vityaz Trieste Bathyscaphe
Palau	6000-7322	1.64-1.84	08/1957	Vityaz
Bougainville	6000-8725 6000-8700	2.29-2.76 2.21-2.70	10/1951 03/1952	Galathea Vityaz
Tonga	7428-9318 6000-8820	1.40-1.74 1.14-1.54	03/1952 12/1957	Galathea Vityaz
Kermadec	6000-8845 6000-7293	1.22-1.68 1.10-1.64	03/1952 01/1958	Galathea Vityaz
Banda	6,000-7,293 6,000-7,213	3.43-3.63 3.43-3.58	09-10/1930 09/1951	Sellenius Galathea
Hjort	6,200	0.76	07/1976	Dmitriy Mendeleyev
Yavan	6,103-7062 6,040-6,813	1.36-1.52 1.25-1.31	09/1951 02/1959	Galathea Vityaz
Puerto Rico	6,065-8,225	1.98-2.35	02/1973	Akademik Kurchatov
Cayman	6,200-6,900	4.46-4.49	03/1973	Akademick Kurchatov
South Sandwich	6,047-7390 6,697-7,060	-0.27- -0.09 -0.23- -0.14	1963, 1964 12/1971	Eltanin Akademik Kurchatov

Note. Expedition data: Akademik Kurchatov--Filatova, Vinogradova, 1974; Arsen'yev et al., 1975a, b; Archimede--Cherbonnier, 1964; Vityaz--Bogoyavlenskiy, 1955; Bogorov, Kreps, 1958; Leont'yev, 1960; Galathea--Bruun, Kiilerich, 1955; Kiilerich, 1964; Dmitriy Mendeleyev--Leont'yeva, 1978; Eltanin--Jacobs, 1965 [in: Filatov, Vinogradova, 1974]; Riofu-Maru, Masuzawa, Akamatsu, 1962; Snellius, Riel et al., 1950; Trieste, Piccard, Dietz, 1963.

a considerably lower O_2 concentration, 0.92-1.35 ml/l, i.e., averaging about 15% saturation [Leont'yeva, 1985]. This is the only incidence of such a strong divergence in the data of different expeditions and such a severe drop in the O_2 concentration. Nevertheless, even such a low O_2 concentration did not adversely affect the animal population in the trench; at the same time, this station obtained numerous photographs of the bottom which depicted abundant and diverse fauna [Lemche et al., 1976]. Numerous animals were collected in 1975 in this same trench during two trawlings conducted by Vityaz [Beliaev, Mironov, 1977a].

Thus, based on temperature, salinity and oxygen content the water of the deep-sea trenches are not distinguished by any specific features and these factors may not have a limiting impact on the development of life in the ultra-abyssal depths versus the abyssal. In the same way, the complete absence of light is characteristic not only for the depths of the trenches, but also for the abyssal zone depths.

CURRENTS

As a result of a comprehensive review of the conditions in deep-sea trenches, V. G. Bogorov and Ye. M. Kreps [1958] concluded that the mixing of water in them encompasses the entire water mass to the very bottom and occurs relatively rapidly. This allowed these authors to conclude that radioactive wastes could not be buried in the trenches. The oxidized layer on the surface of the benthic deep-sea trench sediments also indicates the mobility of water of the actual near-bottom layer [Bezrukov, Petelin, 1962].

During descents of the Archimede bathyscaphe in 1962 to the almost maximum depths of the Kuril-Kamchatka and Izu-Bonin trenches, currents were found near the bottom whose velocities reached 0.2 knots, i.e., about 10 cm/sec [Anonym, 1962]. Based on the changes at the bottom of the Philippine trench in different sections at depths from 9,600 to 9,800 m, currents were found with average speed of 1.8-7.5, and maximum up to 31.7 cm/sec [Hessler et al., 1978].

Based on a review of numerous hydrological data and data of V. V. Leont'yeva [1985] it is concluded that the deep-sea trench waters are subject to mixing and participate in the overall ocean water circulation.

HYDRODSTATIC PRESSURE

A factor that distinguishes the ultra-abyssal zone from all the overlying ocean layers is the hydrostatic pressure which continually increases with depth. It is common knowledge that pressure increases by 1 atm for every 10 m increase in depth, and at depths 6,000-11,000 m reaches enormous levels of 600-1,100 atm. For organisms inhabiting almost 98.5% of the ocean floor and in the water mass comprising over 99% of the ocean, regions with this pressure are beyond the normal existence conditions both now and during the entire evolution path of these organisms. It is therefore a priori undoubted that only comparatively few organisms could adapt to such unusual conditions for the overwhelming majority of the ocean's population.

Chapter 10 will cover the role of pressure as an environmental factor.

FLOOR RELIEF

The deep-sea trench floor relief is distinguished by extreme diversity and complexity, and has a number of features that are common for all or the majority of trenches. "All trenches have extended outlines...Their length fluctuates from one-two hundred to two-three thousand kilometers...All trenches are very narrow. Their width on the isobath 6,500 m for the most part does not exceed several dozen kilometers. The trench slopes have a slightly complex profile that is more gently sloping in the upper section, and steeper in the shallower section. Their average steepness fluctuates from 5 to 15°, but the slopes are usually divided into a number of steep projections and gently sloping steps within which the incline may fluctuate from several minutes to 45° and more. The height of the steep, almost sheer projections reaches 1,000-1,500 m in places. The trench cross profiles have a characteristic V-shape, but they are also characterized by a narrow, flat floor which is a surface of sedimentary mass that fills the deepest part of the trenches. For the most part, the width of the flat floor is very small, about 2-5 km, but local expansions are observed up to 20-30 km" [Udintsev, 1962, p. 58-59]. The greatest width about 40 km, is found in the floor of the Puerto Rico trench [Heezen, Laughton, 1963]. The greatest trench depths are often several separate basins that are divided by shallower depths. Descriptions of the floor relief and numerous cross profiles of the Pacific Ocean trenches showing their extremely complicated relief are given in the monographs of G. B. Udintsev [1972], as well as the publications of A. Kiilerich [1959], R. Ficher and R. Raitt [1962] and D. Kheys [1970].

SEDIMENTS

The trench floor and their gently slope steps are characterized by fine-grained noncalcareous sediments of aleurite-argillaceous and argillaceous silts. Sedimentation often does not occur at all on the steep projections of the slopes. The trench slopes are therefore characterized by numerous sections with base rock exposed outcroppings [Bezrukov, 1955, 1957, 1970]. Numerous bedrock fragments and stones, etc. are found on the trench floors. They fall there from the slopes due to underwater rockslides and are also brought from shallow depths by suspension currents caused by the high seismic activity in the trench zones [Petelin, 1960; Bezrukov, Petelin, 1962]. The numerous residues of aquatic and land vegetation that have been repeatedly found on the trench floor by various expeditions witness to the abundant removal into the coastal hadal trenches from the shallows and even from the land (see, e.g.: [Bruun, 1958; Wolff, 1975; Wolff, 1976b, 1979]. Redeposition of sediments via removal is apparently a normal phenomenon for trenches [Larsen, 1968].

The rates of sedimentation on different sections of the slopes and trench floor may differ considerably depending on the nature of the relief even up to local absence of current sediments [Bezrukov, 1955]. Several direct analyses of the sedimentation rate (by ion-thorium method) showing levels from 0.5 to 6.3 mm in 1,000 years have been obtained for trench slopes in the northwest Pacific Ocean.

There are no known direct analyses of the sedimentation rate for the trench floor by radioactive methods, but based on lithological data of sediment columns, the sedimentation rate on the floor of the Kuril-Kamchatka trench varies from 5-10 to 50-1,000 mm over a century [Bezrukov, Romankevich, 1970] which is considerably greater than the levels for abyssal ocean depths. The trenches on the whole are thus ocean regions where the sedimentation rates are considerably higher than on the bed [Bezrukov et al., 1961; Zverev et al., 1961; Bezrukov, Romankevich, 1970; Lisitsyn, 1971].

It may be stated that the deep-sea trenches are giant sedimentation tanks that accumulate both particles from the water surface layers, and those transported from the ocean bottom sections adjoining the trenches. Everything that somehow falls into the deep-sea trenches to depths below the neighboring sections of the ocean bottom remain at these depths, thus determining the high sedimentation rate on the trench flat floor.

The complex relief of the trenches, the related differences in the sedimentation rate in various sections, and the diverse types of substrate from fine-grained silts to solid exposed surfaces, as well as the ground vegetation residues create in the trenches diverse ecological niches that promote the existence of the most ecologically diverse benthic population. Intensive sedimentation, and consequently, the abundance of nutrients coming to the bottom in the marginal trenches located in the highly productive ocean zones should ensure the abundant development of the animals inhabiting them.

Sediments of the trench floor located in the ocean productive regions are characterized by a considerably higher C_{org} content than sediments in ocean bed regions that are far from the shores [Romankevich, 1970, 1977].

In addition to the impact of high pressure that limits the qualitative diversity of the ultra-abyssal population, there are also conditions in a number of trenches that foster abundant quantitative development of those animals that could adapt to life under extremely high pressure conditions, and diversity of their life forms.

SEISMIC ACTIVITY AND VOLCANISM

A characteristic map of essentially all the deep-sea trenches, their location in the high seismic activity and volcanism zones is given in [Udintsev, 1955; Rikitake, 1970; Sayks, 1970; Menard, 1971; Khain, 1973; Shepard, 1976; Ballard, Emory, 1976; Jumars, Hessler, 1976; et al]. It follows from these publications that under the trench floor and on the boundary of the island curves and trenches earthquakes are usually noted with a comparatively shallow depth of the foci (50-150 km). General earthquake foci and active volcanoes confined to the island curves are graphically illustrated in Fig. 13-15. Volcanogenic material is a significant filler of the trenches

Figure 13. Relationship between Deep-Sea Trenches in the Marginal Sections of the Pacific Ocean and Earthquakes

Key:

1. trench
2,3. earthquakes
2. medium-focal
3. deep-focal [per: Shepard, 1976]
4. Aleutian
5. Kuril-Kamchatka
6. Japan
7. Nansei
8. Mariana
9. Philippine Mindanao
10. Zondskiy
11. Tonga
12. Kermadec
13. Central American
14. Peru
15. Chile

Таким образом, наряду с влиянием высокого давления, ограничивающим качественное разнообразие населения ультраабиссальной зоны, в ряде желобов существуют и условия, способствующие обильному количественному развитию тех животных, которые смогли приспособиться к жизни в условиях крайне высокого давления, и разнообразию их жизненных форм.

СЕЙСМИЧЕСКАЯ АКТИВНОСТЬ И ВУЛКАНИЗМ

Характерная чарта практически всех глубоководных желобов — их расположение в зонах высокой сейсмической активности и вулканизма [Удинцев, 1955; Рикитаке, 1970; Сайкс, 1970; Менард, 1971; Хаин, 1973; Шепард, 1976; Ballard, Emory, 1976; Jumars, Hessler, 1976; и др.]. Как следует из перечисленных работ, под дном желобов и на границе островных дуг и желобов обычно отмечаются землетрясения со сравнительно небольшой глубиной очагов (50—150 км). Обилие очагов землетрясений и действующих вулканов, приуроченных к островным дугам, наглядно видно из рис. 13—15. В заполнении желобов в значительном количестве участвует вулканогенный материал

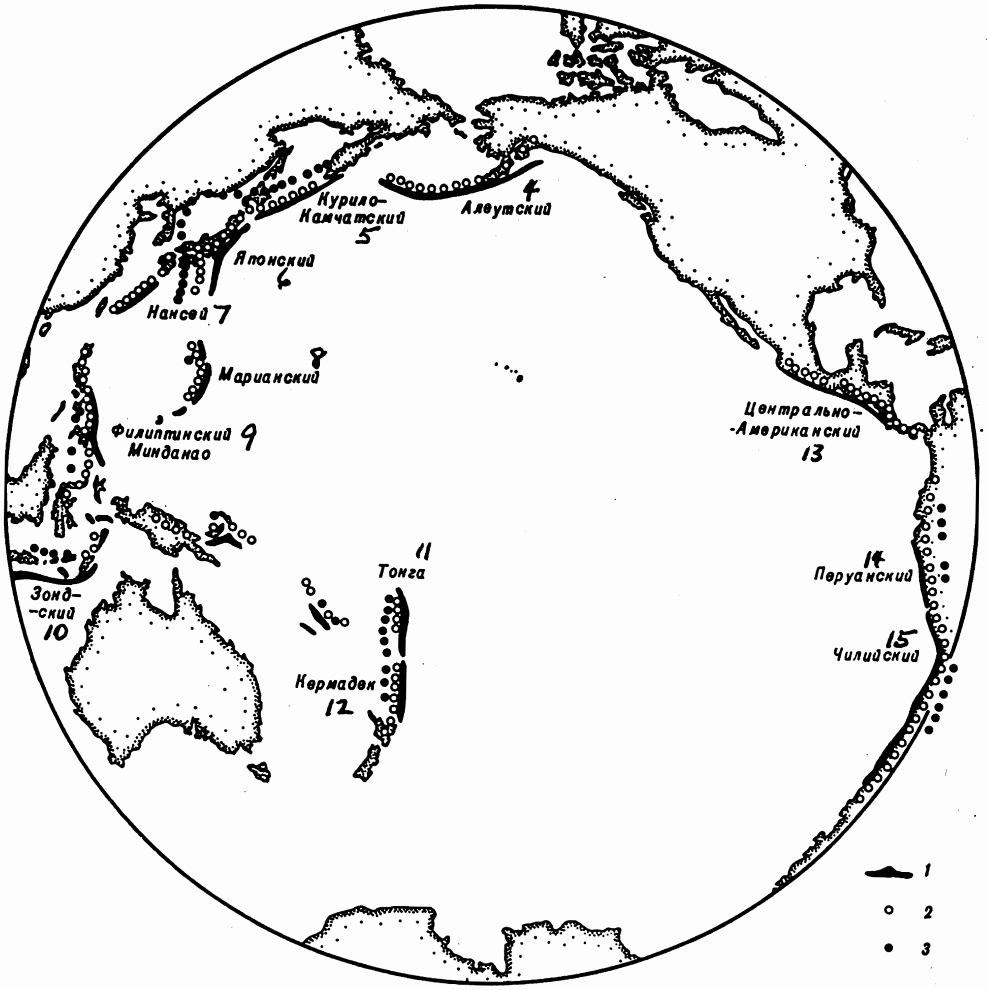

Рис. 13. Связь глубоководных желобов краевых частей Тихого океана с землетрясениями

1 — желоба; *2,3* — землетрясения: *2* — среднефокусные, *3* — глубокофокусные [по: Шепард, 1976]

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Figure 14. Volcanism and Earthquakes in the Kuril-Kamchatka Trench Region

Key:
1-3. earthquake epicenters with focal depth 0-60 km (1), 61-300 km (2), over 300 km (3)
4. active land-based earthquakes
5. underwater volcanoes [per: Udintsev, 1955, simplified]

[Khain, 1973]. Among the thin silts of the deep-sea troughs accumulations are often found of argillaceous pellets and large boulders up to tens of centimeters in size, argillites, tufas and effusive rocks that could only be brought in by underwater slides [Bezrukov, 1970]. A. P. Lisitsyn [1971] also notes the major role of similar processes.

This feature is important for the organisms occupying the trenches because the frequent earthquakes are related to the constantly developing turbidity currents, slides and collapses, that considering the complex relief of the trenches and the often great steepness of their slopes could acquire the nature of mud slides that occur in mountain regions on the Earth's surface, and could cause catastrophic consequences, even the complete death of the animal population on significant sections of the trench floor. The following data could indicate the scales of these phenomena. In the period from 1900 through 1950 in Japan (primarily in its Eastern section) and in its adjoining Pacific Ocean region there were over three thousand strong earthquakes and moderately strong earthquakes [Rikitake, 1970]. The

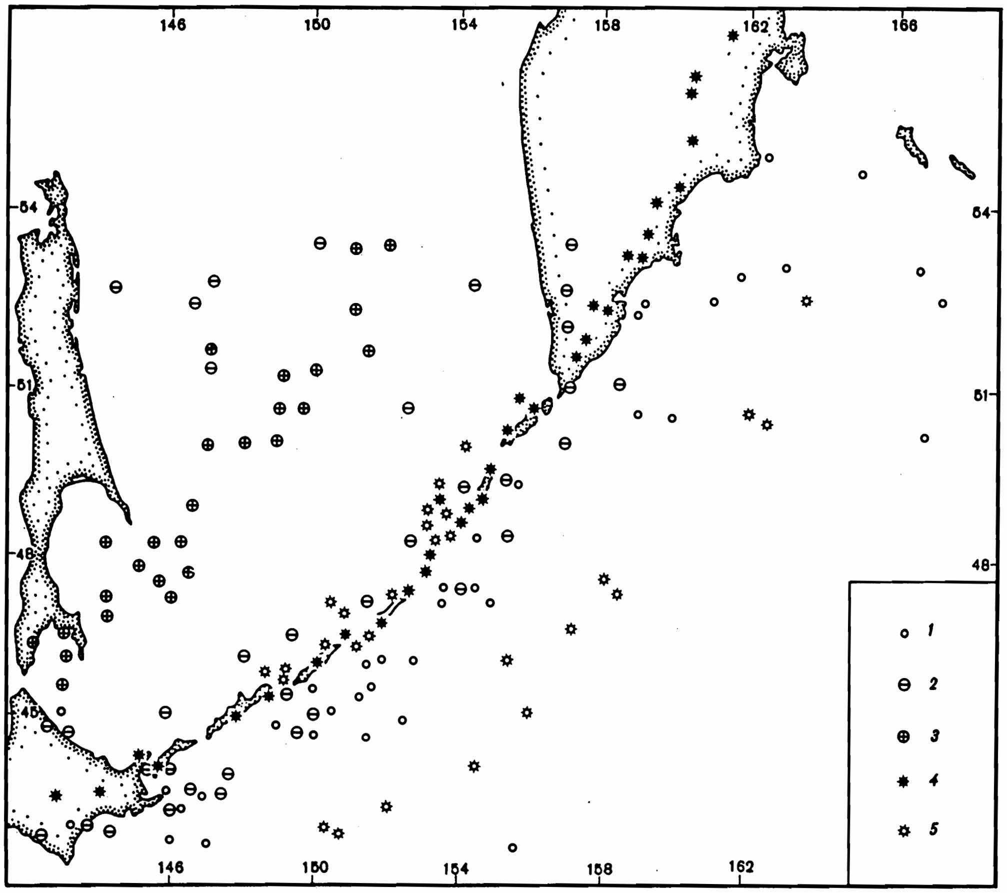

Рис. 14. Вулканизм и землетрясения в районе Курило-Камчатского желоба

1–3 – эпицентры землетрясений с глубиной очага 0–60 км (*1*), 61–300 км (*2*), более 300 км (*3*); *4* – действующие вулканы суши; *5* – подводные вулканы [по: Удинцев, 1955 – упрощено]

[Хаин, 1973]. Среди тонких илов глубоководных желобов нередко встречаются скопления глиняных катунов и крупных валунов размером до десятков сантиметров, аргиллитов, туфов и эффузивных пород, которые могли быть принесены только подводными оползнями [Безруков, 1970]. Большую роль подобных процессов отмечает и А.П. Лисицын [1971].

Для населяющих желоба организмов эта особенность желобов важна потому, что с частыми землетрясениями связаны постоянно возникающие мутьевые потоки (turbidity currents), оползни и обвалы, которые при сложном рельефе желобов и нередко большой крутизне их склонов могут приобретать характер селей, происходящих в горных районах на поверхности Земли, и вызывать катастрофические последствия вплоть до полной гибели животного населения на значительных участках дна желобов. О масштабах этих явлений можно судить по следующим данным. За период с 1900 по 1950 г. в Японии (в основном в ее восточной части) и в прилегающем к ней районе Тихого океана произошло более трех тысяч сильных и умеренно сильных землетрясений [Рикитаке, 1970]. Только в результате одного сильного землетрясения в Японии в 1923 г. объем перемещенных оползнями осадков в заливе Сагами достиг огромной величины – 710 км^3 (см.: [Безруков, 1970][1]).

Вероятно, результаты сильных землетрясений, происходящих в непосредственной

volume of sediment slides moved as a result of one strong earthquake in Japan in 1923 in the Gulf of Sagami reached enormous levels, 710 km^3 (see: [Bezrukov, 1970]).

Probably, the results of the strongest earthquakes that occurred in direct

Figure 15. Epicenters of Deep-Focal and Medium-Depth Earthquakes in the Japan Region and Adjoining Waters in 1926-1956 [per: Rikitake, 1970]

Key:

1. 60-100
2. 101-200
3. 201-300
4. 301-400
5. 401-500
6. > 500 km

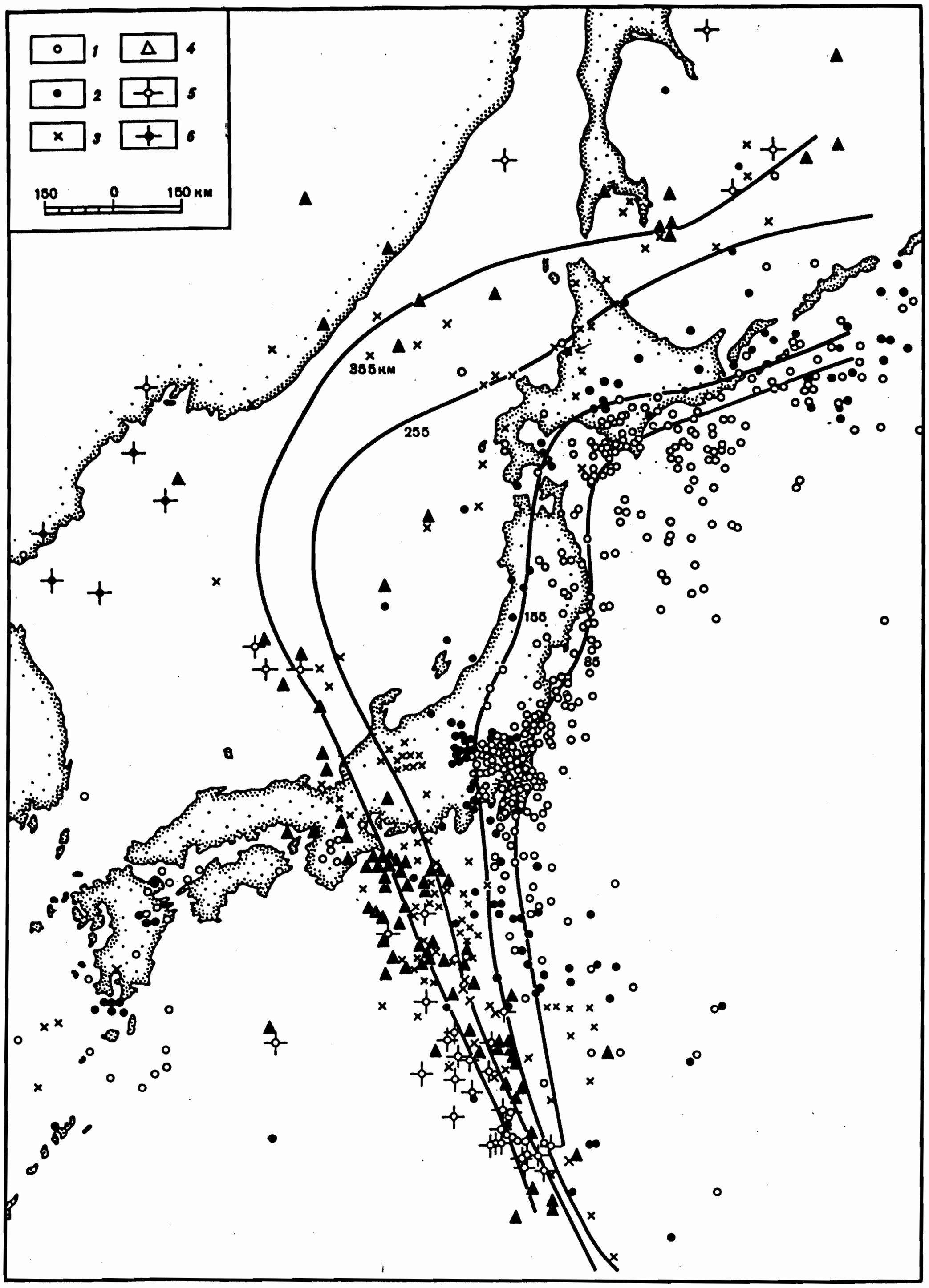

Рис. 15. Эпицентры глубокофокусных и средней глубины землетрясений в районе Японии и прилежащих вод за 1926–1956 гг. [по: Рикитаке, 1970]

1 – 60–100; *2* – 101–200; *3* – 201–300; *4* – 301–400; *5* – 401–500; *6* – > 500 км

proximity to the trenches could elicit in them such catastrophic consequences. It is apparently this type of slide that is related to the detection [Bandy, Rodolfo, 1964] in the surface layer of the ground obtained from a depth over 6 km in the Chile trough of a whole complex of comparatively shallow Foraminfera with calcareous shells that is not inherent to these depths. The slide results probably also explain the absence of other trawling catches obtained by Vityaz in 1957 from depths about 9 and 11 km from the bottom of the Mariana trench [Birstein et al., 1958].

It is indicative, however, that trench floor sections on which animals were buried due to slides are apparently populated comparatively rapidly by animals from neighboring sections that were not exposed to the slide effect. This is indicated by the extreme rarity of trawling catches from the ground, but without animals. We do not know of any other similar cases except for the two aforementioned catches in the Mariana trench.

AGE OF THE TRENCHES

Figure 16. Diagram Explaining the Development of a Marginal Trench by Subduction of One Lithospheric Plate under Another [per: Menard, 1971]

Key:

1. Lithosphere
2. Asthenosphere

близости от желобов, могут вызывать в них столь же катастрофические последствия. По-видимому, именно с такого рода оползнем связано обнаружение [Bandy, Rodolfo, 1964] в поверхностном слое грунта, полученного с глубины более 6 км в Чилийском желобе, несвойственного таким глубинам целого комплекса сравнительно мелководных фораминифер с известковой раковиной. Вероятно, результатами оползней объясняется и отсутствие животных в полученных "Витязем" в 1957 г. двух траловых уловах, принесших грунт с глубин около 9 и около 11 км со дна Марианского желоба [Бирштейн и др., 1958].

Показательно, однако, что участки дна желоба, на которых в результате оползней происходит захоронение животных, видимо, сравнительно быстро заселяются животными из соседних, не подвергшихся воздействию оползня участков. Об этом свидетельствует чрезвычайная редкость траловых уловов с грунтом, но без животных. Кроме двух упомянутых выше ловов в Марианском желобе, другие аналогичные случаи мне не известны.

ВОЗРАСТ ЖЕЛОБОВ

О возрасте и долговечности желобов имеется очень мало данных, но известно, что желоба могут существовать на протяжении 10^7 лет и более [Фейрбридж, 1974]. По данным, приводимым тем же автором, формирование Алеутского желоба происходило в раннетретичное или позднемеловое время. По-видимому, формирование желоба Пуэрто-Рико происходило с начала третичного периода [Fisher, Hess, 1963]. По другим данным, этот желоб, вероятнее всего, сформировался в эоцене [Бенс, 1970; Валяшко и др., 1975]. В течение кайнозоя сформировались и глубоководные желоба Тихого океана [Кропоткин, Шахварстова, 1965; Удинцев, 1965, 1972; Менард, 1966; и др.]. Формирование одного из наиболее молодых желобов – желоба Кайман, по разным данным, происходило на границе эоцена–олигоцена [Хаин, 1975; Хаин и др., 1975], а возможно, и позднее [Erickson et al., 1970].

Таким образом, в их современном виде почти все глубоководные желоба, видимо, сформировались в кайнозое. Однако процессы субдукции на границах литосферных плит могут продолжаться значительно дольше – существовавшее когда-то дно желоба

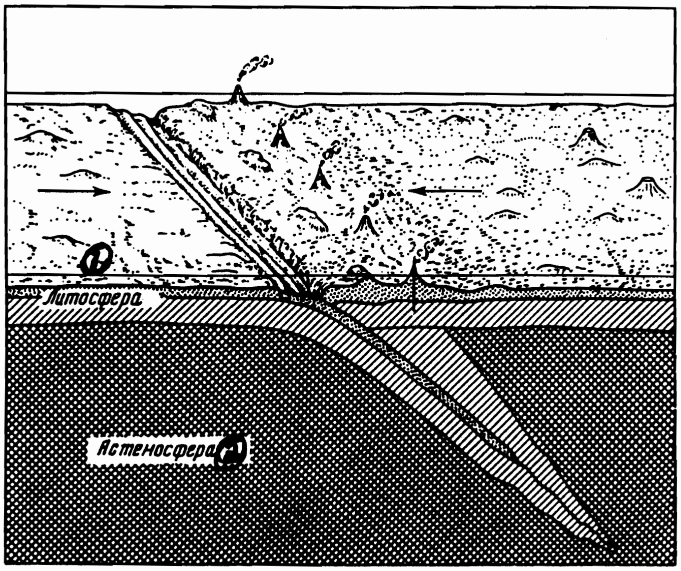

Рис. 16. Схема, объясняющая возникновение краевого желоба путем субдукции одной литосферной плиты под другую [по: Менарду, 1971]

There is very little data regarding the age and longevity of the trenches, but it is known that the trenches may exist for 10^7 years and more [Feyrbridzh, 1974]. Based on the data cited by the same author, the Aleutian trench was formed in the early Tertiary or Late Cretaceous time. The Puerto Rico trench was apparently formed from the beginning of the Tertiary period [Fisher, Hess, 1963]. Based on other data, this trench was most likely formed in the Eocene [Bens, 1970; Valyashko et al., 1975]. The Pacific Ocean deep-sea trenches were also formed during the Cenozoic [Kropotkin, Shakhavarstova, 1965; Udintsev, 1965, 1972; Menard, 1966; and others]. Based on various data, one of the youngest trenches, the Cayman trench, was formed on the border of the Eocene-Oligocene [Khayn, 1975; Khayn. et al., 1975], and possibly, even later [Erickson et al., 1970].

Almost all of the deep-sea trenches in their modern form were thus apparently formed during the Cenozoic period. The subduction processes at the depths of the lithospheric plates, however, could continue much longer, the formerly existing trench floor continues to be submerged under the boundary plate into the asthenosphere where it is destroyed (Fig. 16) [Menard, 1971]. The bottom of the marginal trenches thus should gradually be renewed, and also the trench configuration during a geologically lengthy time may change. But insofar as these processes are extremely slow, they may not prevent the preservation in a certain trench of its fauna over a lengthier time than the existence of the trench in its modern appearance.

CHAPTER 2.

HISTORY OF THE ULTRA-ABYSSAL FAUNA STUDIES

Many publications have covered the history of the ocean depth animal world. In particular, an extensive survey is made of the deep-sea biological research and main deep-sea expeditions that were made in the 1960's in the monograph of R. Menzies et al. [1973]. I will therefore dwell here only on the history of studies on the life in the greatest ocean depths from 6 to 11 km.

The fact that the ocean floor is populated everywhere by diverse animals all the way to depths of about 6,000 m was proved without a doubt for the first time as a result of the famous British round-the-world 1872-1876 expedition on the Challenger under the leadership of W. Thomson [1880]. Additionally, this expedition was able to obtain the first small sample from the bottom of the Japan trench of soil by a sounding tube from depth 7,220 m. Fourteen species of Foraminifera shells were defined from this sample [Brady, 1884]. Finding of the Foraminifera however could still not be considered proof of the existence at this depth of living organisms, since it was not known whether these Foraminefera were taken alive, or only their empty shells were found, and it could not be excluded that they were removed posthumously from a shallower depth.

A quarter of a century later, in 1899, an expedition on the American research vessel Albatross made the first trawling at a considerably greater depth in the Tonga trench. But it was unsuccessful, only fragments of the skeleton of a siliceous sponge were brought up from a depth of 7,632. A more precise determination of the system affiliation of these fragments was not successful and it still remained unknown whether they belonged to a sponge that really lived at that depth, or were removed there from a shallower depth [Agassiz, 1902; Nybelin, 1951].

But within two years, in August, 1901, the expedition of the Prince Albert of Monaco on the yacht Princesse-Alice made a successful trawling at depth 6,035 m in the Atlantic Ocean in the Zeleniy Mys trough. In the catch from this trawling there were Echiuroidea, Asteroidea, 4 specimens of two types of Ophiuroidea and benthic fish [Koehler, 1909; Sluiter, 1912; Roule, 1913]. This catch proved for the first time that various multi-cellular animals could exist even somewhat deeper than 6,000 m. It is true that the depth of this catch was only 200 m above the maximum depth from which multi-celled animals were obtained by the Challenger expedition.

The next step in studying life at the hadal ocean depths was only made in 1948 when the Swedish expedition headed by Hans Pettersson on the ship Albatross (we will call it Albatross-2) caught benthic animals in the Puerto Rico trench from a depth of 7,625-7,900 m [Nybelin, 1951]. In this catch there were representatives of four benthic species: 2 Polychaeta, 1 Isopoda and 20 Holothurioidea [Eliason, 1951; Madsen, 1955; Nordenstamm, 1955]. Thus, within only over 70 years after the expedition on Challenger for the first time animals were successfully obtained from a depth considerably greater than the depth studied by Challenger. During this entire period, the long maintained opinion continued to dominate that a lifeless zone existed in the deep ocean, but as knowledge was accumulated about it, its boundary was shifted deeper and deeper. It is important that literally on the eve of the catch from the Puerto Rico trench by the Albatross-2 expedition the very leader of this expedition in a small book entitled Zagadki morskikyh glubin [Riddles of the Sea Depths] [Pettersson, 1948] expressed doubt as to the possible existence of life at depths over 6,500-7,000 m.

The Albatross-2 expedition started a period of extremely intense study of life at the hadal ocean depths due to the qualitative leap in the development of deep-sea research which will be discussed in more detail in the next chapter. This period was primarily linked to numerous expeditions on the Soviet vessel Vityaz and the Danish year-round expedition on Galathea.

The Vityza research began in 1949 and already during the first trip in the Pacific Ocean, the expedition under the supervision of L. A. Zenkevitch made a successful trawling in the Kuril-Kamchatka trench at depth 8,100 m. The first report about this trawling was published immediately by the leader P. V. Uschakov. In the catch that was obtained from a depth over 8 km there were over 150 benthic invertebrates belonging to no less than 20 species from 10 different classes [Uschakov, 1952]. The Danish year-round expedition on Galathea in 1951-1952 under the supervision of Anton Bruun obtained 16 trawling catches and 4 bottom grab samples below 6,000 m in five deep-sea trenches (Philippine, Yavan, Banda, Bougainville and Kermadec), and in the Philippine trench its greatest depths were studied and 3 trawling catches were made from depths 9,820 to 10,200 m, and a dredging sample that brought Holothurioidea from depths 10,120 m. It was thus proven that life in the ocean exists everywhere all the way to depths over 10 km.

As a result of the Galathea work, the number of classes whose representatives were found at depths over 6 m increased to 25, and below 10 km animals were found that belonged to at least six different classes [Bruun, 1951, 1935a, b, 1955, 1956a, b, 1958; Wolff, 1958, 1959a, b, 1960, 1966; and numerous special publications by various authors in the "Galathea Report" series].

During the 1953 special Vityaz expedition (14th trip) in the Kuril-Kamchatka trench region, 6 mass trawling catches were obtained from depths ranging from 6,860 to 9,500 m. The study results of the benthic fauna obtained by Vityaz in 1949 and 1953 in the Kuril-Kamchatka trench were correlated in the articles of L. A. Zenkevitch, Ya. A. Birstein, and G. M. Beliaev [1954, 1955], and for the first time the isolation of depths over 6-7 km was substantiated in the system of ocean vertical biological zonality into a special ultra-abyssal zone with specific ultra-abyssal fauna "mainly consisting of species that are capable only of inhabiting these great depths and are endemic for each trench" [Zenkevitch et al., 1955, p. 377].

Almost simultaneously with the Soviet authors, and independently of them, the same conclusion was drawn based on the results of the Galathea expedition by its leader A. Bruun [1956a] who proposed for the depth zone over 6,000 m the terms "hadal' and "hadal fauna"[1]

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[1] The literature has never discussed which of the two names suggested for the greatest depth zone and its fauna have the greater right to existence, considering the convenience of use, the question of priority, etc. However, it is currently clear that both names have caught on, although the Russian literature more often uses "ultra-abyssal" and the foreign uses "hadal". Insofar as both terms were proposed independently and based on original data, it is expedient to consider them to be equivalent and not mutually exclusive.

In subsequent years (1954-1959), the Vityaz expeditions (19, 20, 22, 24-27, 29th trips) continued an intensive study of the dep-sea trench fauna in the north and west Pacific Ocean. The fauna of the Japan, Aleutian, Izu-Bonin, Volcano, Ryukyu, Bougainville, Vityaz, New Hebrides, Tonga, Kermadec and Mariana trenches were examined to a certain measure, as well as depths over 6 km in certain troughs of the Pacific Ocean bed [Zenkevitch, Filatova, 1958; Zenkevitch et al., 1959; Birstein et al., 1958; Birstein, Vinogradov, 1959; Beliaev et al, 1958, 1960; Beliaev, Sokolova, 1960a; Birstein, Sokolova, 1960; Filatova, Beklemishev, 1959; Filatova, Levenstein, 1961].

During the work of Vityaz in January, 1958 in the Kermadec trench recently studied by Galathea to depth of somewhat over 8 km, two trawling samples were obtained from depths 9 and 10 km, and in December, 1957 and May, 1958 benthic animals were lifted from depths over 10.5 km (10,415-10,687 m in the Tonga trench and 10,630-10,710 m in the Mariana trench). In the greatest deep-sea sample from the Tonga trench, Foraminifera of several species were found, 1 Nematoda, several Polychaeta, representatives of Amphipoda and Isopoda from the Crustacea, Bivalvia and Gastropoda and Holothurioidea; all the caught animals were very small; the total weight of all the animals (without the Foraminifera) obtained from approximately 1 T of the silt brought in by the trawl was less than 0.5 g. The catch from the greatest depth of the Mariana trench was less diverse, most of it comprised several fairly large samples of Actinia Galatheanthemidae in very long calyptras, in addition to which there were also fragments of Polychaeta and Isopoda and 3 samples of two species of Holothurioidea. These catches (and another taken by Vityaz later also in the Mariana trench) are still the greatest deep-sea catches of any taken.

As a result of the work in the Tonga and Mariana trenches, it was thus proven that representatives of various animal groups exist essentially all the way to the greatest known depths of the World Ocean. Summation of these data with the Galathea data for depths over 10 km in the Philippine trench demonstrated that representatives of at least 9 classes of benthic animals inhabit depths below 10 km.

In 1960 a participant in the Galathea expedition, T. Wolff published the first summary work that covered the data on hadal fauna accumulated by this time [Wolff, 1960]. Based on the calculations of T. Wolff, in the fauna already known by that time from depths over 6,000 m, the endemic species for such depths was 58%.

The presence of living creatures at depth 10,900 m was confirmed on January 23, 1960 by the direct observations of J. Piccard and D. Walsh through the portholes of the Trieste bathyscaphe during its submersion to the maximum depth of the Mariana trench [Piccard, 1960; Piccard, Dietz, 1963].

Vityaz obtained 4 trawling catches and 2 bottom grab samples in 1959 and 1962 in the Yavan trench [Beliaev, Vinogradova, 1961a, b; Kuznetsov, Parin, 1964].

The French expedition of Jacques Cousteau on Calypso obtained two photographs of the bottom with animals at depth about 8,000 m in 1956 in the Romanche trench [Edgerton et al., 1957; Cousteau, 1958]. These were apparently the first photographs that were successfully obtained at these depths. Five years later photographs of the floor with animals were obtained in this trench by the American expedition on the Chain vessel [Pratt, 1962; Heezen et al., 1964].

The American expeditions on Vema in 1958 and on Eltanin in 1962 made successful benthic trawlings at four stations in the Peru-Chile trench that were not previously studied at depths from 6,000 to 6,328 m [Menzies et al., 1959; Menzies, 1963, 1964]. The second of these expeditions in the same region of the Peru trench obtained photographs of the bottom at depth about 6,000 m which clearly showed different animals. The Eltanin 1963 expedition examined the South Sandwich trench and obtained three trawling samples from depths to 7,700 m and another three stations obtained bottom photographs with animals from depths 6,700 to 7,600 m [Studies in Antarctic Oceanolgy, 1965; Hartman, 1967b]. Another two trawlings somewhat deeper than 6,000 m were made by the Vema expeditions in 1959 in the Atlantic Ocean, in the Puerto Rico trench and in the southern part of the Argentina trough [Clarke, 1961; Menzies, 1962], and by the American expedition on Chain by dragging on the northern slope of the Puerto Rico trench at depth 5,800-6,400 m [Todd, Low, 1964]. Finally, one very successful trawling at depth about 7,000 (6,700-7,340) m was made in 1961 by the Japanese expedition (JEDS-4) on the ship Riofu-Maru in the Japan trench [Nasu, Sato, 1962; Suyehiro et al., 1962].

The Scripps Institute of Oceanography (United States) expedition in 1962 on the vessel Spencer F. Baird obtained about 4,000 photographs of the bottom and benthic water layer with numerous animals in five trenches of the western tropical section of the Pacific Ocean (Palau, New Britain, Bougainville, Santa Cruz and New Hebrides) at depths from 6,700 to almost 9,000 m. A careful study of these photographs and analysis of the extremely diverse animals imprinted on them, however, required considerable time. This work was conducted by a group of highly skilled Danish zoologists, specialists for different taxonomic groups of animals, mainly from the Galathea expedition participants (H. Lemche, B. Hansen, F. J. Madsen, O. S. Tendal, T. Wolff). Extremely important results from a detailed study of these photographs that contained a detailed description of the bacterial films and animals found on them and frequently noted for the first time for such depths, as well as ecological remarks, and in a number of cases calculations of the average population of certain animals based on their occurrence on many photographs were only published at the end of 1976. The article is illustrated with 33 tables of photographs containing over 150 individual photographs [Lemche et al., 1976].

The French bathyscaphe Archimede in 1962 also made several successful submersions to the bottom initially in the Kuril-Kamchatka trench, and then at the junction of the Japan and Izu-Bonin trenches. A total of 8 submersions were made over 7,000 m, including 3 deeper than 9,000 m. The greatest submersion depth in the Kuril-Kamchatka trench was 9,545 m [Hout, 1968]. During submersion in the second region (to the southeast of the Gulf of Tokyo) the submersion participants F. G. Uo and H. Delauze through the bathyscaph portholes observed fish at depth 9,180 m. A sample of liquid gray silt with small Holothurioidea in it was also successfully obtained from this depth [Anonym, 1962, 1963; Delauze, Peres, 1963; Cherbonnier, 1964].

In May-June 1964 the Archimede bathyscaphe made several hadal submersions in the Atlantic Ocean in the Puerto Rico trench. The deepest of these Archmide submersions reached a floor depth of 8,300 m. According to the preliminary published data, the fauna in the depths of the Puerto Rico trench were considerably more abundant than previously thought. At this depth fish were also observed through the bathyscaphe porthole [Anonym, 1964; Wolff, 1964; Peres, 1965].

Finally, in 1967 Archimede again made a hadal submersion near Japan. During the eight submersions at depths from 5,500 to 9,750 m numerous benthic animals were successfully observed and several samples were taken using the mechanical "arm" located outside of the bathyscaphe [Anonym, 1967; Laubier, 1985].

The majority of dep-sea trenches had already been studied to a certain measure by 1965 and considerable data had been accumulated on the fauna populating them. The summary of the author that was published in 1966 [Beliaev, 1966b; Belyaev, 1972] covered these data.

The subsequent years are characterized by further intensification in studies on the fauna in the greatest ocean depths. In addition to continued study of life in the unexamined or poorly examined trenches, primary attention was focused on a more detailed study of the fauna in individual trenches and their neighboring regions of the ocean floor in order to pinpoint the previously already detected data regarding the composition of the ultra-abyssal fauna and laws governing its distribution, detection of the genesis of this fauna, its links to the fauna of the abyssal depths, and obtaining of its quantitative and ecological characteristics.

During the 39th trip of Vityaz in the Kuril-Kamchatka trench in 1966 that was headed by L. A. Zenkevitch as in the previous trips to this trench, a repeated and considerably more detailed examination than previously was made of the fauna in this trench and the adjoining ocean floor. At depths from 6,000 to 9,530, 17 successful benthic trawlings were made and three quantitative bottom grabs were obtained from depths to 8,355 m. Exceptionally abundant catches were obtained of diverse animals, including from the trench greatest depths [Zenkevitch, 1967; articles of many authors in two volumes entitled Trudy Instituta okeanologiya AN SSSR [Proceedings of the USSR Academy of Sciences Institute of Oceanography] that particularly covered the results of this trip: "Fauna of the Kuril-Kamchatka Trench and Conditions of Its Existence", 1970, and "Fauna of the Kuril-Kamchatka Trench," 1971].

Two special expeditions covered the Peru-Chile-trench region. During the 11th trip of the American vessel Anton Bruun in 1965 in the Peru trench at depths to 6.5 km 10 stations obtained trawling samples (in several cases, two samples from large and small trawlings each), on two dredging samples, and on another two, photographs of the bottom [Menzies, Chin, 1966]. During the fourth trip of the Soviet vessel Akademik Kurchatov in 1968 both trawling and bottom grab samples were taken in the Peru-Chile trenches, and in the Chile trench to depth 7,720 m which is close to the greatest depth of this trench [Zenkevitch, 1969b; Zenkevitch, Filatova, 1971]. Similar work was done by Vityaz in 1969 in the area of the Aleutian trench [Moskalev et al., 1973], and the American expeditions on the John Elliott Pilsbury and Gillis in 1967-1975 in the Puerto-Rico and Cayman trenches [Voss, 1967, 1969; Staiger, 1969, 1972; Holthius, 1971; Wolff, 1979; Madsen, 1981].

Several trips by the research vessel Akademik Kurchatov from 1967 through 1973 covered biological work in the Atlantic Ocean, including study of the Atlantic deep-sea trenches. During the 1967 second trip of this vessel, for the first time catches were made of benthic animals from the Romanche trench, two trawlings and one bottom-grab sample from depths up to 7,340 m [Kovalevsksya et al., 1968; Pasternak, 1968; Birstein, 1969a]. During the 11th trip in 1971-1972 that was dedicated to biological studies in the southern Atlantic Ocean, work was conducted in the South Sandwich trench in which 5 extremely abundant trawling catches and 2 bottom grab samples were obtained from depths ranging from 6,050 to 8,116 m [Vinogradova et al., 1974; Mirovon, 1974; Murina, 1974; Turpayeva, 1974; Filatova, 1974; Filatova, Vinogradova, 1974; Basov, 1975; Beliaev, 1975; Gureyeva, 1975; Kudinova-Pasternak, 1975b; Levenstein, 1975]. Another three trawling catches were obtained in this same trip in the Romanche trench [Vinogradova, 1974]. During the 14th trip in 1973 in the Caribbean Sea and its adjoining regions the Puerto Rico and Cayman trenches were studied. The first of them obtained 5 trawling and 2 bottom grab samples deeper than 6,000 m from depths to 8,100 m and the second, 5 trawling and 5 bottom grab samples from depths to 6,950 m [Beliaev, 1974b; Wolff, 1975; Keller et al., 1975; Litvinova, 1975; Mironov, 1975; Nielsen, 1975a, b; Pasternak et al., 1975; Wolff, 1976b, 1979; Datta Gupta, 1977; Fauchald, 1977].

The 57th trip of Vityaz in 1975 in the western tropical section of the Pacific Ocean (the trip was led by N. V. Parin and the benthic fauna team by A. N. Mironov) was extremely productive in terms of study of the fauna in the hadal depths. This trip collected fauna in all the trenches surrounding the Philippine Sea: Ryukyu, Philippine, Palau, Yap, Mariana, Volcano and Izu-Bonin, as well as in the Banda trench. During the three months of work, a record number of catches for one expedition were made at depths over 6,000 m. Thirty trawling catches and 12 bottom grab samples were obtained from eight trenches; 8 successful trawlings were made in the Philippine trench to depth 9,990 m, and from seven trawling catches obtained in the Mariana trench, three trawlings were made at depths over 10 km, including the deepest of all ever made, at depth 10,700-10,730 m. The deepest hadal bottom grab samples were obtained from depth 9,340 m in the Philippine trench and 9,540 in the Mariana trench. The trawling catches obtained in the trenches on this trip are described in detail in the publication [Beliaev, Mironov, 1977a]. Results of processing the data for certain groups of benthic fauna from the collections of this trip are also partially published in [Kamenskaya, 1977a; Kudinova-Pasternak, 1977; Beliaev, Mironov, 1977b; Levenstein, 1978a].

During the 59th trip of Vityaz in 1976, repeated work was conducted in the Japan trench: 5 trawling catches were obtained and one bottom grab sample from depths to 7.5 km. After the 59th trip, the Vityaz continued to sail until 1979, but did not conduct further work in the deep-sea trenches.

During the entire period from 1949 through 1976, Vityaz studied life at the hadal depths during 20 expeditions and examined 16 trenches in the Pacific Ocean and Yavan trench in the Indian Ocean. During this work, from depths over 6,000 m 40 bottom grab samples were obtained and at these depths 106 successful trawlings were conducted, of them 18 at depths over 9 km, including 5 deeper than 10 km. Additionally, in a number of trenches during the Vityaz expeditions fairly numerous plankton catches were made that covered depths over 6,000 m, including several catches of plankton networks in levels limited to these depths. The author's article [Beliaev, 1976] correlates the data on the pelagic and bottom-dwelling fauna of the hadal depths.

During all the expeditions on Vityaz, exceptionally abundant and diverse collections of ultra-abyssal fauna were gathered. Much of the collected data has already been processed and the results have been published, but for the majority of the taxonomic groups of animals data processing has not yet been completed, and apparently will continue for many more years. It is quite substantiated to say that the enormous contribution of Vityaz to the study of life at the hadal depths has not yet been surpassed by any of the other research vessels that also collected animals at such depths.

Vityaz made its last sailing in 1979 and is currently in permanent dock in Kaliningrad where it will become a marine museum. The book Nauchno-issledovatel'skoye sudno Vityaz' i ego ekspeditsi Vityaz Research Vessel and Its Expeditions [1983] covers the correlation of all the oceanographic studies made during the Vityaz trips.

The Soviet research vessel Dmitriy Mendeleyev continued work in the deep-sea trenches starting in 1969. In 1969 it made one trawling in the Puerto Rico trench, in 1972 obtained a bottom grab sample in the Peru trench, and in 1976 during work in the sub-Antarctic waters in the western Pacific Ocean made a detailed study of the relief of the Hjort trench [Zhivago, 1978] and obtained 2 bottom grabs and 3 trawling samples from this trench from depths to 6,650 m [Vinogradova et al., 1978].

The Japanese ship Soyo-Maru in 1972-1980 made 13 trawlings at depths from 6,000 to 6,340 m in the northwest trough of the Pacific Ocean, 2 trawlings at depths about 7.5 km in the Izu-Bonin trench and one in the Mariana trench at depth 8,870 m [Okutani, 1974, 1982], and in 1980 and 1981 the vessel Hakuho-Maru obtained trawlings and 4 bottom grabs samples in the Japan and Izu-Bonin trenches to depths 8,260 m [Gamo, 1983, 1985; Shin, 1984; Kristensen, Shirayama, 1988].

Extremely important results from the standpoint of the use of a box-corer that provides complete meiobenthos samples as well as the use of independent instrument-carriers were obtained in 1970-1975 during several American expeditions, primarily on the Thomas Washington research vessel.

The special publication of P. Jumars and R. Hessler [1976] discusses the data regarding the composition and population of the animals in the very abundant sample taken by the box-corer in the Aleutian trench at depth 7,298 m during the Seventow expedition in 1970. The number of animals (in conversion per 1 m^2), based on the data of this sample, due to the use of a more advanced collection technique was much higher than in the dredging samples obtained previously from similar depths by all other expeditions. During the same expedition, several dredging samples were obtained in the northeast trough of the Pacific Ocean at depths only slightly above 6,000 m [Hessler, Jumars, 1974].

During the Southtow expedition of the same Thomas Washington vessel at seven stations in the Chile trench, descents of camera-controllable bait were made to depths from 6,767 to 7,196 m using an independent instrument-carrier (see the next chapter) [Hessler et al., 1978]. The same work, also using bait traps lowered on an independent instrument-carrier was conducted in 1975 during the Eurydice expedition at depth about 9,600 m in the Philippine trench, and then at depths from 7,353 to 10,592 in the Mariana trench [Wolff, 1976, 1977; Jayanos, 1977; Hessler et al., 1978]. The results of these observations and catches will be discussed in the following chapters. The American expeditions also obtained 13 samples by box-corer and 8 catches by epibenthic trawl at depths up to 9,600 m in the Philippine trench [Hessler et al., 1978].

The fauna of the hadal trenches has possibly been studied by now even more completely than the fauna of many regions of the ocean floor and underwater ocean ridges, and even more so the local elevations. The composition of the population of the trenches is primarily known, the representatives of individual genera and taxons of the highest rank that dominate in the trenches have been revealed. Many laws governing the vertical distribution and geographic dissemination of the trench fauna, and many of its ecological features have been clarified. The accumulated data make it possible to advance a number of suggestions about the origin of the ultra-abyssal fauna.

However, the fauna in some trenches still remains completely unknown, e.g., the marginal trenches: San Cristobal, Admiralty, Central American (Guatemala), as well as the trench-faults: Imperator, Mussau, Lira in the Pacific and Diamantina in the Indian Ocean. The fauna of some other trenches has still not been fully studied. Finally, quite a lot of the fauna data collected in the trenches both by the Soviet and foreign expeditions have still not been processed by the zoologists or specialists in different taxonomic animal groups. The final processing of all of the already collected data will undoubtedly supplement our concepts regarding the trench fauna, but will hardly alter the concepts already formed regarding the characteristic features of this fauna.

In addition to the aforementioned detailed summaries on the trench fauna, more concise compilations been repeatedly published that cover the main data on the composition and uniqueness of the ultra-abyssal, or hadal, fauna, the laws governing its dissemination, its origin, etc. [Wolff, 1970; Beliaev, 1969a, 1971a, 1977a, b, 1980, 1983a, b; Birstein, 1969c, 1971a]. The article published several years ago by the chairman of the Working Group on Ocean Ecology of the International Union of Environmental Protection and Natural Resources, M. V. Angel [1982] that surveys the characteristic features of the trenches and their fauna makes special coverage of the need to protect the deep-sea trenches and their unique

TABLE 3.
TOTAL NUMBER OF CATCHES IN WHICH BENTHIC ANIMALS WERE TAKEN FROM DEPTHS OVER 6000 M, NUMBER OF STATIONS AT WHICH PHOTOGRAPHS OF ANIMALS WERE OBTAINED AT THESE DEPTHS, AND NUMBER OF SUBMERSIONS OF BATHYSCAPHES AND OBSERVATIONS OF ANIMALS THROUGH PORTHOLES (NUMERATOR--WORK OF SOVIET EXPEDITIONS, DENOMINATOR--WORK OF EXPDEDITIONS OF OTHER COUNTRIES)

Depths, m	Number of examined trenches and troughs	Number of trawlings*	Number of bottom grab samples	Catches of animals on bait	Number of stations with bottom photographs **	Bathyscaphe descents ***
6,000-6,500	24	33/39	23/5	-/1	-/4	-/1
6,500-7,000	17	26/7	15/2	-	-/8	-/?
7,000-7,500	17	22/14	9/2	-/1	-/4	-/1
7,500-8,000	12	11/6	3/-	-	-/5	-/?
8,000-8,500	8	13/2	3/-	-	-/2	-/1
8,500-9,000	9	13/3	1/-	-	-/1	-/?
9,000-9,500	4	8/-	1/-	-	-	-/1
9,500-10,000	6	5/1	1/1	-/1	-/5	-/2
10,000-10,500	2	2/2	-/1	-	-/1	-
Over 10,500	2	3/-	-	-/1	-/?	-/1
Total	24	136/77(+8)	56/11(+13)	-/4+?	-/(no less than 30)	-/7(+5)

*Additionally, in the Philippine trench at depths from 6 to over 9 km another 8 trawling expeditions were conducted by the American WHOI (Woodhole Oceanographic Institute) and at the same depths another 13 samples were obtained by the American box-corer expedition USNEL (US Navy Electronic Laboratory). These numbers are indicated in the parentheses.
**Including the photographs that monitor the clusters of animals at the bait lowered to the bottom.
***The bathyscaphe Archimede made another 5 descents to depths over 6, 000 m near Japan in 1967.

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fauna and the impermissibility of any anthropogenic impacts (toxic or ship waste contamination, burial of radioactive wastes[2] ,etc.) that could damage the trench ecosystem.

Summary data on the biological work done below 6,000 m are given in Table 3, and the station data with coordinates and depths are given in Appendix 1. The station locations are also shown in Figs. 2-12.

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[1] The article of V. G. Bogorov and Ye. M. Kreps that was published back in 1958 also covered impermissible burial of radioactive wastes in trenches.

CHAPTER 3
METHODS OF COLLECTION AND OBSERVATIONS OF THE DEEP-SEA FAUNA

The intensive development of the study of the fauna in the hadal depths began at the end of the first half of our century. Samples of benthic animals were only obtained by trawlers and bottom grabs from the deep-sea trenches as a result of the acquisition of ultrasound fathometers-self recorders and the construction of comparatively large research vessels equipped with powerful electric winches and drums that accommodate up to 12-16 km of fairly strong cables and can hold up to at least several tons.

The ultrasound self-recorders allow clarification of the nature of the relief of the studied trench even before the beginning of the trawling operations to its maximum depth and continuous monitoring of the course of change in depths during trawling or lowering of the bottom grab. Without this monitoring, it would be as impossible to trawl on the floor of a deep-sea trench as it would be to lower an instrument on a cable into a mountain ravine from a balloon borne by the wind above this ravine at an altitude of 6-10 km and separated from the earth by a dense cloud layer.

The publication of N. N. Sysoyev [1959] describes in detail the deep-sea trawling winch of Vityaz that made numerous trawlings in many trenches to depths over 10,700 m in the Mariana trench. During operations in the hadal depths in order to ensure sufficient strength of the cable over its entire length, either a continuous cone cable or a graded cable spliced from different diameters had to be used. The trawling winches of the Soviet research vessels adapted for deep-sea trawlings use steel cables ranging in diameter from 6.8 or 7.2 mm on the terminal section and carrying a bottom-submersible instrument to 15.5-16 mm in the base. The spliced cables are assembled so that each cable section had as a minimum a double strength margin, considering the load on it, including the weight of the cable and the instruments attached to it.

One of the main difficulties during trawlings at great depths was determination of the number of cables required based on the direction and velocity of drift of the vessel during the operations. B. Kullenberg [1951], a participant on the expedition Albatross-2, suggested a fairly complicated mathematical calculation for the length of a cable, based on the theoretical course of the cable in the water mass, depending on depth, weight of the cable, instruments, and angle of inclination of the cable at the water surface, depending on the ship drift.

However, the practical work on the ships Vityaz and Akademik Kurchatov demonstrated that it is expedient to use more simplified calculations for this purpose. The fact is that the currents above the great depths in the water mass could change from the surface to the bottom in direction and velocity, and the cable course often does not correspond to the theoretical calculation.

When working with the bottom grab Okean with area 0.25 m^2 lowered on comparatively light, small-diameter cables, the moment that the instrument reached the bottom at depths to 5-6 km usually was recorded by loosening of the cable (dynamometer readings, change in sound of the working winch). It happened repeatedly that the actual length of the discharged cable does not correspond to that calculated by the angle of its inclination at the water surface.

At depths over 6 km, determination of when the bottom grab reaches the bottom is very difficult, and successful descents only occur in favorable weather and with weak drift. It is very indicative that the only bottom grab sample from a depth over 10 km was obtained by Galathea in the Philippine trench only during the fourth descent. The first three attempts were unsuccessful [Bruun, 1958].

During the Soviet expeditions, the deepest hadal samples by bottom grab were obtained during the 57-th trip of Vityaz in 1975 from depth 9,340 in the Philippine trench (station 7,208) and from depth 9,540 in the Mariana trench (station 7,363) (see Appendix 1). The American expeditions in the Philippine trench obtained several samples by box-core 0.25 m^2 from depths to 9,600 m.

During deep-sea trawlings, especially at depths over 6 km, the moment when the trawl reaches the bottom by tension of the cable for the most part cannot be noted since the trawl weight is too low compared to the weight of the actual cable. Approximate calculations of the requisite cable length should therefore be made based on the only accessible criterion, the cable slope angle at the surface. Considering that these calculations may only provide an approximate concept about the required cable length, the Soviet ships made them by the simplest method, adopting the depth as the leg of a right triangle, and the cable length as the hypotenuse. A table, calculated to the maximum depths for different slope angles of the cable with 5° intervals was used in this case for convenience and speed. The actual length of the cable had to be increased versus the calculated length the stronger that the ship drift was in order to guarantee that the trawl reached the bottom and so that it could reach the bottom horizontally, without floating on low relief irregularities. At depths over 5-6 km and with cable inclination angles at the surface up to 30-40°, it is usually sufficient to increase the cable length versus the calculated by 20-30%. Insufficient length of the cable could mean that the trawl does not reach the bottom. These cases were common in all the deep-sea expeditions. Excessive increase in the cable length results in its entangling and the formation on it of knots and kinks that could break it.

A precise idea about the moment when the trawl or bottom grab reaches the bottom is provided by automatic ultrasonic signaling devices that send signals at the moment the equipment touches the floor or at a specific distance from the bottom. The American expedition on the research vessel Thomas Washington in the Philippine trench work also used pingers to depth 9,600 m [Wolff, 1976a] (see Fig. 33, b).

It is extremely important for an oceanographic ship used for deep-sea biological work to be able to move at minimum speeds on the order of 0.1-1 knots. At this speed, deep-sea trawling may be done even if there is no drift in calm weather. Additionally, if there is too strong drift, this permits compensation for the ship drift at the requisite (low) speed. The trawling technique used on the 11th trip of Akademik Kurchatov during work under very difficult sub-Antarctic conditions in the South Sandwich trench was covered in the article of E. A. Rebayns [1974], who was then the captain of Akademik Kurchatov and was the direct leader of the deep-sea trawlings to produce abundant and diverse fauna for the first time in this trench.

Deep-sea trawlings on the Soviet research ships were usually made by the Sigsby-Gorbunov trawl with frame width 2.5 m and with side bars that prevent entangling of the trawl bag beyond the frame (Fig. 17). A similar attachment as an additional frame was mounted on the trawl of the Eltanin research vessel (Fig. 18). If there is a calm relief and soft soil, a dual trawl with six-meter frame as used on the Galathea yields very effective results.

In order to obtain approximate quantitative characteristics of the benthic fauna based on trawling catches, Ye. I. Kudinov, a colleague in the Institute of Oceanography, designed a trawl-graph, an instrument in the form of freely rotating wheel with an automatic recorder contained in it. The trawl-graph was suspended from the frame of a benthic trawl, and the automatic recorder recorded the length of the path traversed by the trawl over the bottom. Approximate calculations of the bottom area covered by the trawl and the weight of the catch per unit of area [Zenkevitch et al., 1955] were made in the first years of work of Vityaz based on the trawl-graph readings.

It was then found, however, that the trawl-graph readings could also be used for an approximate quantitative evaluation of the macrobenthos biomass only under the most favorable conditions, with a calm bottom relief on the ocean floor and

Figure 17. Benthic Trawls Use for Deep-Sea Trawling on
Soviet Research Vessels

Key:
A. Sigebi-Gorbunov trawl
B. double six-meter Galathea trawl

loose silt sediments, freely passing during trawling through the trawling nets [Beliaev, Sokolova, 1960b]. During operations in the deep-sea trenches with complex macro- and micro-relief of the bottom, when the depth during trawling often changed by hundreds of meters, the trawl-graph readings were very unreliable and did not allow an actual judgment of the bottom area covered by the trawl. Under such conditions, when two or three trawl-graphs were used at the same time that were suspended on the opposite ends and in the middle of the trawl frame, their readings could diverge by tens of times. The further use of trawl-graphs was therefore halted in work in deep-sea trenches.

Until the middle of the current century, the majority of deep-sea expeditions (with the exception of the Danish expedition on the research vessel Ingolf) essentially discounted the meiobenthos that at great depths plays an important role in the benthic fauna. The smallest animals were either washed out together with the silt from the trawl through the trawl mesh during elevation, or were lost when the samples were washed on the deck on large-mesh metal sieves. Starting in 1954-1955, Vitayz introduced the practice of washing both trawling and bottom grab samples in a small net made of the finest mesh about 0.5 mm which allows collection of even the smallest meiobenthic animals. The Soviet ships use a special washing machine [Fedikov, 1960] to wash the samples. In order to prevent washing out of the entire soil and

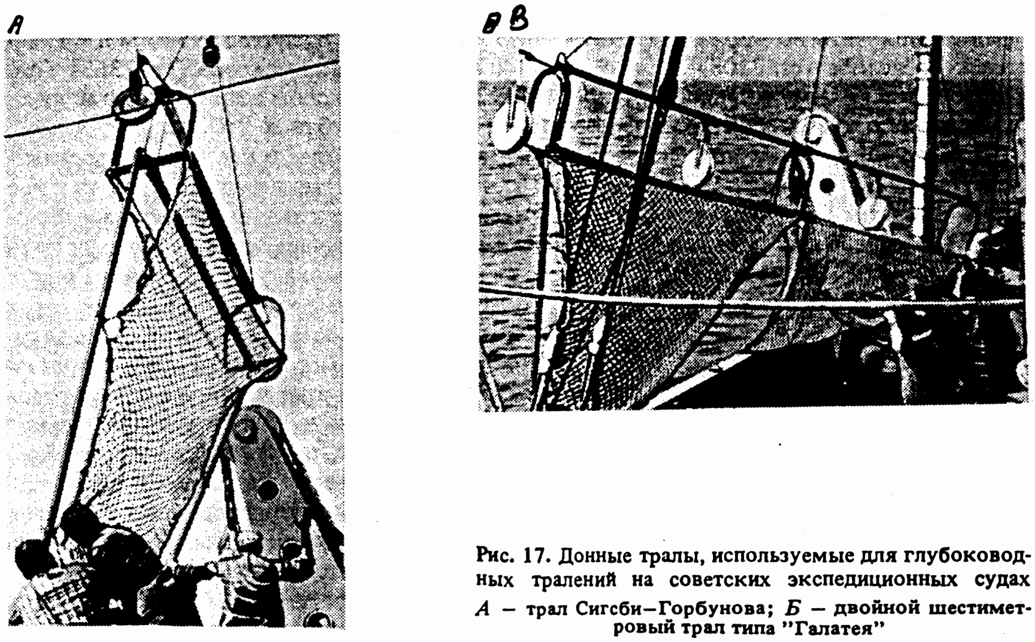

Рис. 17. Донные тралы, используемые для глубоководных тралений на советских экспедиционных судах
А – трал Сигсби–Горбунова; *Б* – двойной шестиметровый трал типа "Галатея"

лых илистых осадках, свободно проходящих при тралении через ячеи траловой сети [Беляев, Соколова, 1960б]. При работах же в глубоководных желобах со сложным макро- и микрорельефом дна, когда за время траления глубина нередко меняется на сотни метров, показания тралографа оказываются весьма ненадежными и не позволяют судить о фактически обловленной тралом площади дна. В таких условиях при одновременном использовании двух или трех тралографов, подвешенных на противоположных концах и в середине траловой рамы, их показания могут расходиться в десятки раз. Поэтому в дальнейшем от использовании тралографов при работах в глубоководных желобах пришлось отказаться.

До середины текущего столетия большинством глубоководных экспедиций (за исключением датской экспедиции на э/с "Ингольф") мейобентос, играющий на больших глубинах важную роль в донной фауне, практически не учитывался. Наиболее мелкие животные либо вымывались вместе с илом из трала через ячеи тралового мешка при подъеме, либо терялись при промывке пробы на палубе на крупноячеистых металлических ситах. Начиная с 1954–1955 гг. на "Витязе" была введена в практику промывка и траловых и дночерпательных проб в мягкой сетке из мельничного сита с ячеей около 0,5 мм, что позволяет собирать даже мелких животных мейобентоса. Для промывки проб на советских судах используется специальный промывной станок [Федиков, 1960]. Для предотвращения вымывания всего грунта и мейобентоса при подъеме трала внутрь концевой части тралового мешка вшивается мешок из мелкоячеистого сита или более плотной ткани. Сходная методика промывки траловых проб была использована в 50-х годах на американском экспедиционном судне "Вима". Теперь промывка принесенного тралом грунта на мягких мелкоячеистых ситах общепринята при глубоководных работах.

При обследовании Перуанского желоба американскими экспедициями на э/с "Илтенин" и "Антон Бруун" для сбора мейобентоса был успешно применен малый треугольный трал Мензиса с мешком из мелкоячеистого сита и входным отверстием шириной 1 м и высотой 10 см (см. рис. 18). Как указывает Мензис [Menzies, 1963], этот трал вместе с небольшой трубкой для взятия колонки осадков можно опускать на тросе диаметром 4,8 мм с лебедки, используемой для гидрологических работ. Однако этот трал может быть использован для сбора глубоководного бентоса лишь наряду с обыч-

meiobenthos, when the trawl is lifted, a bag made of fine-mesh or denser cloth is sewn inside the end of the trawling bag. A similar trawling sample washing technique was used in the 1950's on the American expedition Vema. Washing of the soil brought up by a trawl in soft small-mesh sieves is now generally accepted in bottom drag operations.

During examination of the Peru trench by the American expeditions on the research vessels Eltanin and Anton Bruun to collect meiobenthos, a small triangular Menzies trawl was successfully used with a bag made of a small-mesh sieve and inlet 1 m and height 10 cm (see Fig. 18). As indicated by Menzies [1963], this trawl together with a small pipe to take a sediment column could be lowered on a cable of diameter 4.8 mm from a winch to be used for hydrological operations. However, this trawl may be used to collect deep-sea benthos only in addition to

Figure 18. Trawls of Research Vessel Eltanin
Large Six-Foot (in Rear), Small Trawl Menzies to Collect
Meiobenthos (in Middle), and Machine for Washing Fish (Right)
[per: Menzies, Chin, 1966]

the regular, larger trawls, since the comparatively large animals are essentially not trapped by it.

Starting in the late 1960's, expeditions from the United States and other countries used an epibenthic sled/sledge trawl for deep-sea work that was a good trap for the macrobenthos populating the bottom surface and the ground layer surface (a more detailed description and an image of it are given in the publication of [Hessler, Sanders, 1967]) (Fig. 19). R. Hessler et al. [1978] mention eight samples taken by the sledge trawl in the Philippine trench at depths to 9,600 m. At the end of the 1970's in England, a quantitative closing epibenthic sledge trawl was designed whose operation was monitored and controlled by acoustic signals sent from the ship and received on it from the trawl sensors [Aldred et al., 1976]. Then [Rice et al., 1982] developed a somewhat modified sledge equipped with a camera that made photographs of the bottom 1.5 m ahead of the sledge every 15-30 sec, and an odometer that recorded the length of the path made by the sledge over the bottom until its closure. The sledge of one of the models was equipped with three bags trawling the bottom surface, two side ones with a net with 4.5 mm mesh and a central one with 1 mm mesh; it also had under them a superbenthic net (0.33 mm mesh) to catch bottom animals in the layer 0.6-1.2 m above the floor. This sledge model was successfully tested during several catches in the Atlantic Ocean, so far at depths to 4 km.

During the 1964-1965 trip in the northwest Indian Ocean of the North German research vessel Meteor, H. Thiel used the following special, extremely labor-intensive, but extremely effective technique of collecting deep-sea microbenthos [Thiel, 1966]. A section 25 cm^2 in size was cut from the surface of a dredging sample by a special instrument (Meiosteicher). The resulting sample was fixed in Formalin

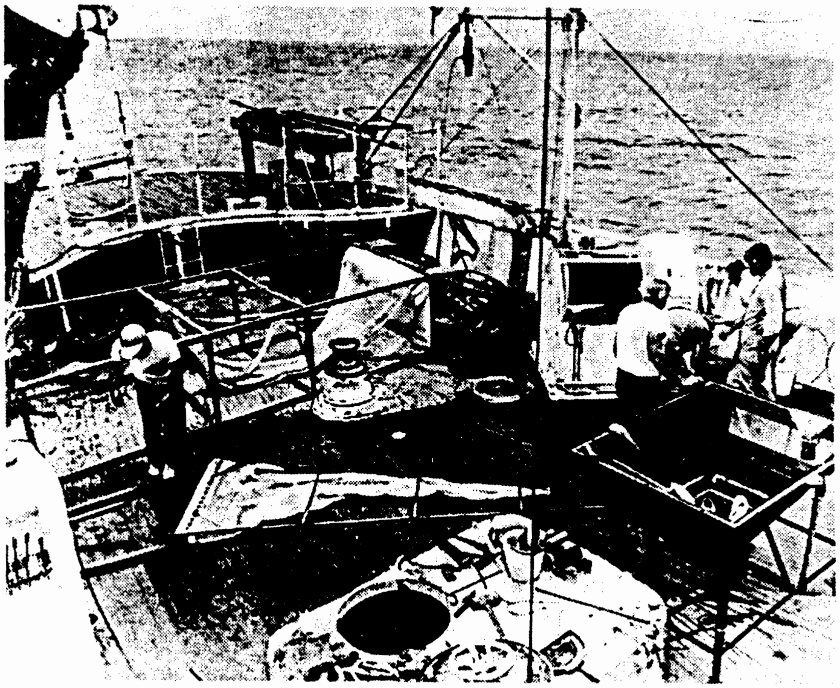

Рис. 18. Тралы э/с "Илтенин" – большой шестифутовый (на заднем плане), малый трал Мензиса для сбора мейобентоса (в середине), станок для промывания проб (справа) [по: Menzies, Chin, 1966]

ными, более крупными тралами, так как сравнительно крупных животных он практически не улавливает.

С конца 60-х годов экспедиции США и ряда других стран обычно используют для глубоководных работ эпибентический салазочный трал (sledge trawl, epibenthic sled), хорошо облавливающий макробентос, населяющих поверхность дна и поверхностный слой грунта (подробное описание и изображение его приведено в работе [Hessler, Sanders 1967]) (рис. 19). Р. Хесслер с соавторами [Hessler et al., 1978] упоминает о восьми пробах, взятых салазочным тралом в Филиппинском желобе на глубинах до 9600 м. В конце 70-х годов в Англии сконструирован количественный замыкающийся эпибентический салазочный трал, работа которого контролируется и управляется акустическими сигналами, посылаемыми с судна и принимаемыми на нем от датчиков трала [Aldred et al., 1976]. В дальнейшем [Rice et al., 1982] были разработаны несколько модификаций такого трала, снабженного фотокамерой, делающей каждые 15–30 с фотоснимки дна в 1,5 м впереди трала, и одометром, регистрирующим длину пути, пройденного тралом по дну до его замыкания. Трал одной из этих моделей оборудован тремя мешками, облавливающими поверхность дна, – двумя боковыми из сети с ячеей 4,5 мм и центральным с ячеей 1 мм, а также расположенной над ними супербентической сетью (ячея 0,33 мм) для лова придонных животных в слое 0,6–1,2 м над дном. Трал этой модели был успешно опробован во время нескольких ловов, проведенных в Атлантическом океане, – пока на глубинах до 4 км.

Во время плавания в 1964–1965 гг. в северо-западной части Индийского океана западногерманского э/с "Метеор" Х. Тиль применил специальную крайне трудоемкую, но чрезвычайно эффективную методику сбора глубоководного микробентоса [Thiel, 1966]. С поверхности дночерпательной пробы специальным прибором ("Meiosteicher") вырезался участок размером 25 см^2. Полученная проба фиксировалась формалином,

Figure 19. Epibenthic Sled Trawl [per: Hessler, Sanders, 1967]

stained with a special dye that acts only on animal tissue, and using a set of sieves was separated into fractions with particle size 65-100, 100-150 and over 150 µm. Then, a binocular microscope was used to sample all the animals that were easily distinguishable from the soil particles due to the staining. After using this method, Thiel successfully detected rich microfauna in the samples taken from the abyssal depths (to 5,000 m). It was found the total number of organisms of the microbenthos (predominantly the smallest Nematoda) are from 16 to 160,000 samples/m^2. For the first time at such depths representatives were found of Kinorhyncha and Tardigrada that were previously unknown from depths over 400 m, as well as numerous Harpacticoida. The use of this technique apparently will permit a further detection in deep-sea trenches of many representatives of the microbenthos belonging to groups that have not yet been found at these depths.

The Danish expedition on Galathea to obtain quantitative benthic samples used the Petersen bottom grab 0.2 m^2 [Bruun, 1958]. All samples from depths over 6,000 m by the Soviet expeditions were obtained by the bottom grab Okean-50 0.25 m^2 lLisitsyn, Udintsev, 1955]. New, more advanced models of bottom grabs were repeatedly designed (see, e.g.: Wigley, 1967; Menzies, Rowe, 1968; Thiel, Hessler, 1974, and others]). A model of a combined photobottom grab was even designed. This bottom grab initially photographs the bottom and then takes a sample on the photographed section (Fig. 20). Since the mobile animals often avoid capture by the bottom grab, the photograph could serve as a significant supplement to the sample. This method was used, for example, to establish that the population density of the Ophiuroidea inhabiting the depths of the slope is considerably higher than the bottom grab samples indicated [Emery et al., 1965; Wigley, Emery, 1967]. However, none of these models of bottom grabs were used at depths over 6,000 m.

The so-called box corer with area 0.25 m^2 [Hessler, Jumars, 1974] (Fig. 21) was extremely effective in bringing a sample with completely intact section of the bottom from which it was taken and suitable for use at any depths of the ocean. Because the sediment surface is preserved intact in the samples obtained by this corer, the small animals, meiobenthos, were counted successfully with great accuracy. This corer model obtained a sample in the Aleutian trench from depths 7,298 m [Jumars, Hessler, 1976]. As a result of washing of this sample on a net with mesh 0.3 mm, 318 specimens of macrobenthic animals were collected and 538 specimens of meiobenthos (the authors included in this group the Foraminifera Allogromida, Nematoda, Harpaticoida, Turbellaria and Ostracoda) which in conversion yields respectively 1,272 and 2,152 specimens/m^2. Based on the data cited by the authors in different publications in 1956-1968, in the samples previously obtained from depths over 6,000 m by bottom grabs of other models, the number of animals did not exceed 200 specimens/m^2. Several samples by a corer of this type were obtained in the Philippine trench all the way to depth 9,600 m [Wolff, 1976a;

Tendal, Hessler, 1977; Hessler et al., 1978].

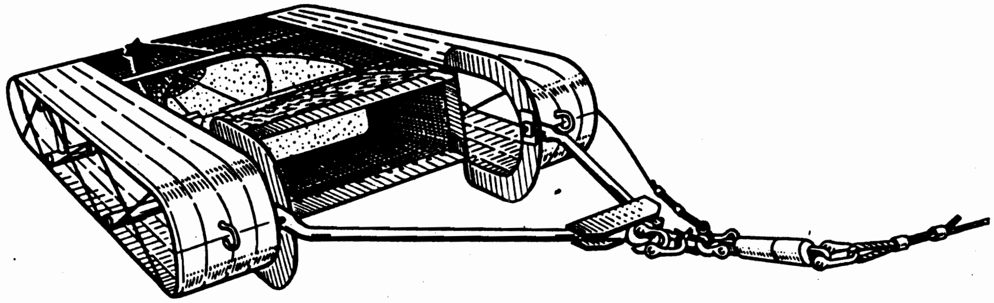

Рис. 19. Эпибентический салазочный трал [по: Hessler, Sanders, 1967]

окрашивалась специальным красителем, действующим только на ткани животных, и разделялась при помощи набора сит на фракции с размером частиц 65–100, 100–150 и более 150 мкм. После этого под бинокуляром производилась выборка всех животных, хорошо отличимых после окраски от частиц грунта. Применив эту методику, Тилю удалость обнаружить богатейшую микрофауну в пробах, полученных с абиссальных глубин (до 5000 м). Оказалось, что общее число организмов микробентоса (преимущественно мельчайших нематод) составляет в пересчете от 16 до 160 тыс.экз./м². Впервые были обнаружены на таких глубинах представители Kinorhyncha. и Tardigrada, ранее неизвестные с глубин более 400 м, а также многочисленные Harpacticoida. По-видимому, применение этой методики позволит в дальнейшем обнаружить и в глубоководных желобах многих представителей микробентоса, относящихся к группам, до сих пор не найденным на этих глубинах.

Датской экспедицией на "Галатее" для получения количественных проб бентоса был использован дночерпатель Петерсена 0,2 м² [Bruun, 1958]. Советскими экспедициями все пробы с глубин более 6000 м были получены дночерпателем "Океан-50" 0,25 м² [Лисицын, Удинцев, 1955]. Неоднократно конструировались новые, более совершенные модели дночерпателей (см., напр.: [Wigley, 1967; Menzies, Rowe, 1968; Thiel, Hessler, 1974; и др.]). Была даже сконструирована модель комбинированного фотодночерпателя. Такой дночерпатель сначала фотографирует дно, а затем берет пробу на сфотографированном участке (рис. 20). Поскольку подвижные животные зачастую успевают избежать захвата дночерпателем, фотография может служить существенным дополнением к полученной пробе. Именно этим путем удалось, например, установить, что плотность поселений обитающих на глубинах склона офиур значительно выше, чем давали основание считать дночерпательные пробы [Emery et al., 1965; Wigley, Emery, 1967]. Однако дночерпатели всех этих моделей не использовались на глубинах более 6000 м.

Чрезвычайно эффективным, приносящим пробу с полностью не нарушенной поверхностью того участка дна, с которого она была взята, и пригодным для использования на любых глубинах океана оказался так называемый коробчатый дночерпатель (box corer) площадью 0,25 м² [Hessler, Jumars, 1974] (рис. 21). Благодаря сохранению ненарушенной поверхности осадка в пробах, полученных этим дночерпателем, удается с большой точностью учитывать мелких животных – мейобентос. Дночерпателем этой модели была получена проба в Алеутском желобе с глубины 7298 м [Jumars, Hessler, 1976]. В результате промывки этой пробы на сите с ячеей 0,3 мм было собрано 318 экз. животных макробентоса и 538 экз. мейобентоса (авторы включили в эту группу формаминифер Allogromida, нематод, гарпактицид, турбеллярий и остракод), что в пересчете дает соответственно 1272 и 2152 экз./м². По приведенным авторами данным из разных работ, опубликованных в 1956–1968 гг., в пробах, полученных ранее с глубин более 6000 м дночерпателями других моделей, число животных не превышало 200 экз./м². Несколько проб дночерпателями этого типа было получено в Филиппинском желобе вплоть до глубины 9600 м [Wolff, 1976a; Tendal, Hessler, 1977; Hessler et al., 1978].

Figure 20. Combined Photobottom grab (per: Wigley, Emery, 1971)

It is very important that the box corer could descend with 25 sections of cross-section 10x10 cm installed in it and thus obtain a sample with area 0.25 m^2 already divided into 25 subsamples that could be studied independently [Wolff, 1976a]. As a result, it became possible to compare among themselves the composition and population of the animals obtained from different subsamples with an area of 100 cm^2, and to judge the degree of homogeneity or inhomogeneity of the small-scale distribution of the meiobenthos.

Underwater photography yielded a lot in terms of studying the fauna at the greatest depths. The first photographs of the bottom with animals were obtained at ocean depths about 40 years ago [Ewing et al., 1946]. In the last 30 years slightly more than two dozen photographs have been published of the bottom with animals obtained at depths over 6,000 m by the French expedition on Calypso in the Romanche trench [Cousteau, 1958] and several American expeditions in 1961-1965 in the Romanche, Puerto-Rico, South Sandwich, Peru, New Britain and New Hebrides trenches [Pratt, 1962; Menzies, 1963; Heezen et al., 1964; Heezen, Johnson, 1965; Heezen, Hollister, 1971; Menzies et al., 1973]. All of these photographs were obtained from depths from 6,000 to 8,650 m. In the Peru trench the expedition on Eltanin at two stations obtained bottom photographs somewhat deeper than 6,000 m with animals and at the same stations trawling was conducted during which some of the animals were caught that were in these photos [Menzies, 1963] which facilitated their analysis. The Soviet expeditions during these same years obtained numerous bottom photographs at abyssal depths, but only once in the Northwest trough of the Pacific Ocean at depth 6,145 m [N. Zenkevitch, 1970].

A group of Danish zoologists [Lemche et al., 1976] in 1976 published extremely interesting results of studying more than 4,000 bottom photographs and partially the benthic layer obtained by the 1962 American expedition on the Spencer F. Baird ship in five trenches of the western tropical section of the Pacific Ocean (see

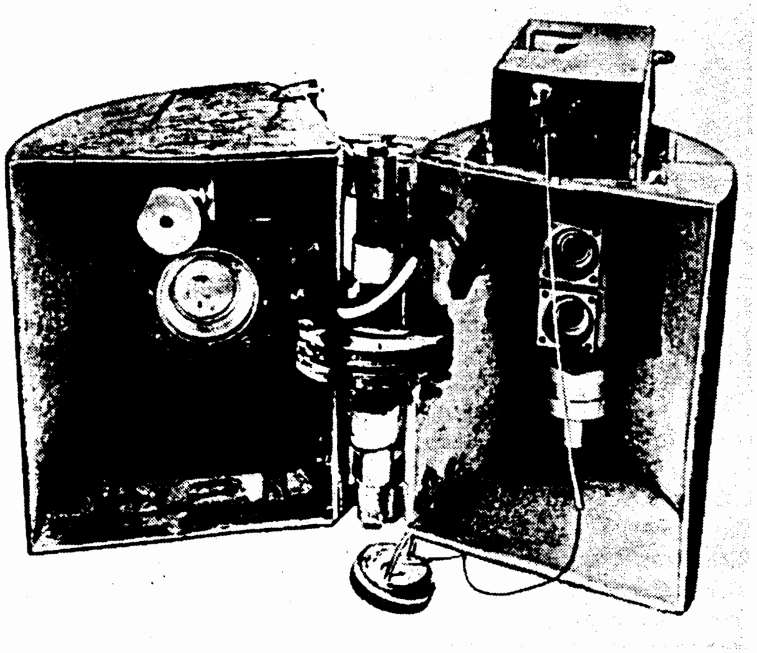

Рис. 20. Комбинированный фотодночерпатель (по: Wigley, Emery, 1971)

Весьма существенно, что коробчатый дночерпатель можно опускать со вставленными в него 25 секциями квадратного сечения размером 10Х10 см и таким образом получать пробу площадью 0,25 м^2, уже разделенную на 25 субпроб, которые можно исследовать независимо [Wolff, 1976a]. В результате этого становится возможным сопоставлять между собой состав и численность животных, полученных из разных субпроб площадью 100 см^2, и судить о степени однородности или неоднородности мелкомасштабного распределения мейобентоса.

Очень многое в отношении изучения фауны наибольших глубин дало подводное фотографирование. Впервые фотографии дна с животными были получены на глубинах океана около 40 лет назад [Ewing et al., 1946]. За последующие 30 лет было опубликовано немногим более двух десятков фотографий дна с животными, полученных на глубинах более 6000 м французской экспедицией на "Каллипсо" в желобе Романш [Cousteau, 1958] и несколькими экспедициями США в 1961–1965 гг. в желобах Романш, Пуэрто-Рико, Южно-Сандвичев, Перуанский, Ново-Британский и Ново-Гебридский [Pratt, 1962; Menzies, 1963; Heezen et al., 1964; Heezen, Johnson, 1965; Heezen, Hollister, 1971; Menzies et al., 1973]. Все эти фотографии были получены с глубин от 6000 до 8650 м. В Перуанском желобе экспедицией на "Илтенине" на двух станциях были получены несколько глубже 6000 м фотографии дна с животными и на тех же станциях проведены траления, во время которых были частично пойманы животные, попавшие и на фотографии [Menzies, 1963], что облегчило определение последних. Экспедициями СССР за эти же годы были получены многочисленные фотографии дна на абиссальных глубинах, но лишь однажды в Северо-западной котловине Тихого океана на глубине 6145 м [Н. Зенкевич, 1970].

В 1976 г. группой датских зоологов [Lemche et al., 1976] были опубликованы чрезвычайно интересные результаты изучения более чем 4000 фотографий дна и отчасти придонного слоя, полученных американской экспедицией 1962 г. на судне "Спенсер Ф. Бэрд" в пяти желобах западной тропической части Тихого океана (см. Прило-

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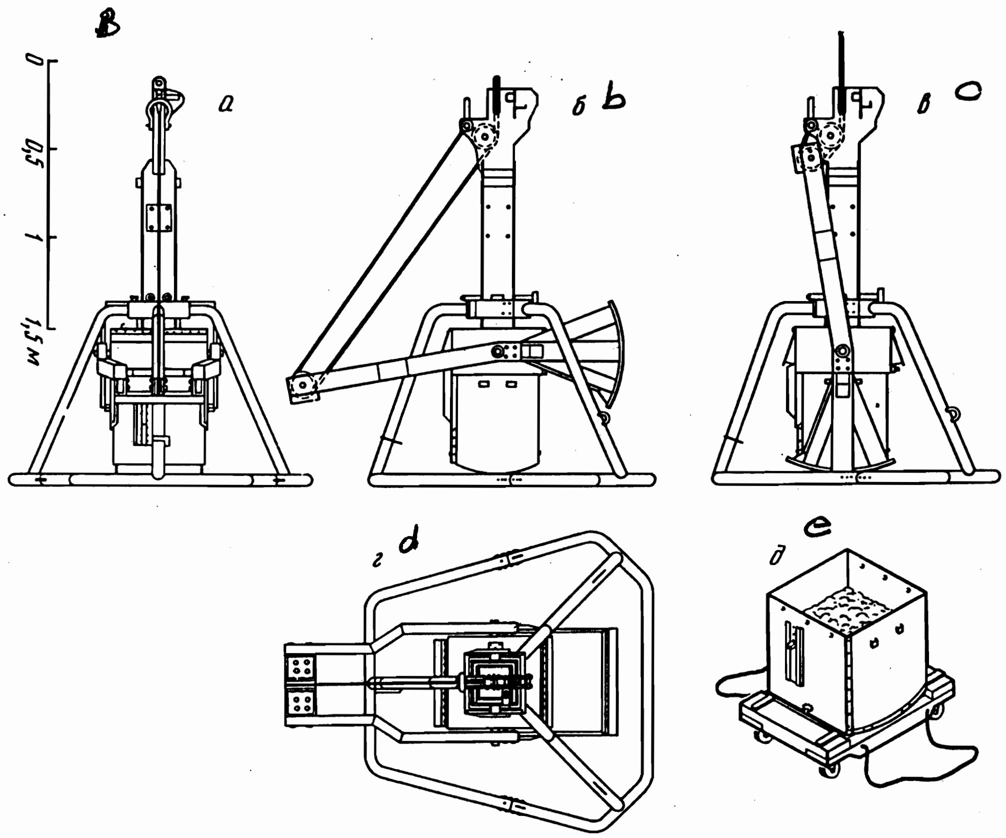
Figure 21. Box Corer 0.25 m^2 (A) and Diagram of Its Layout

Key:
a. View from the side of the closing lever in the open position
b. View from the side in the open position
c. View from the side of the closing lever in the closed position
d. View from above in the open position
e. withdrawn box with soil sample placed on sled
[A--per Wolff, 1976a; B--per Hessler, Jumars, 1974]

Рис. 21. Коробчатый дночерпатель 0,25 м^2 (*А*) и схема его устройства (*Б*)

а – вид со стороны замыкающего рычага в открытом положении; *б* – вид сбоку в открытом положении; *в* – вид со стороны замыкающего рычага в закрытом положении; *г* – вид сверху в открытом положении; *д* – вынутый короб с пробой грунта, помещенный на тележку [*А* – по: Wolff, 1976a; ·*Б* – по: Hessler, Jumars, 1974]



Appendix 1) at depths from 6,758 to 8,930 m. The cameras were towed by a ship on a cable at ping-controlled distance 1-2 m above the bottom and in intervals 10-15 sec bottom photographs were made that covered a certain area (from 0.5 to 10 m^2). During each of the successful descents, the camera was able to take photos covering from several hundreds to over 2,000 m^2 of the bottom. The photographs were taken simultaneously by two connected cameras, one taking black-and-white, the other color pictures and producing paired stereoscopic images. Examination of these three-dimensional color images was very helpful in analyzing the photographed animals. In particular, these photographs helped Lemche et al. to create a graphic reconstruction of a new group of animals (apparently, class rank) of the Hemichordata type, Lophenteropneusta (see Fig. 47).

Underwater photography has been successfully used in recent years to monitor the clusters of animals and their behavior near bait lowered to the bottom. This work was conducted in the Chile, Philippine and Mariana trenches, and to depths of 9,800 and 10,500 m in the last two [Wolff, 1976a; Hessler et al., 1978].

Methods have recently been developed for successful use at depths of the ocean bottom not only of underwater photography, but also underwater television. The scales and outlook for study of the ocean bottom and animals living on it using these methods can be judged from the recently published works of Foell and Pawson [1986]. During several American expeditions in 1979-1982 on the research vessel Prospector in the eastern tropical section of the Pacific Ocean in a program to study the distribution on the bottom of clusters of iron-manganese concretions, studies were made of the bottom at depths from 4,400 to 5,100 m using movie cameras towed at a distance of 1-5 m above the bottom or underwater TV units. The work of Foell and Pawson covered the partial results of their study of epibenthic animals on the more than 70,000 bottom images obtained by these expeditions. It is important that as in previously known data of trawling collections from such depths there was a dominance of Echinodermata on these photographs (over half of the 70 detected species). A number of previously unknown (new) animal species were also detected. It is true that a precise analysis of the latter will only be possible after they are caught. As far as I know, underwater television has not yet been used at depths over 6,000 m.

In recent decades, another step has been taken in the study of the hadal depths that has opened up basically new opportunities; new independent bathyscaphes have been created to allow the researcher to submerge to the ocean bottom at any depths, to make direct observations through portholes, and even obtain benthic samples [Piccard, 1960; Piccard, Dietz, 1963; Cherbonnier, 1964; Wolff, 1964; Peres, 1965; Laubier, 1985].

There are currently also a number of other underwater research vessels that are more maneuverable than the bathyscaphes and not as cumbersome, like the French Siana and the American Alvin that could be transported on the accompanying ship. These underwater vessels were able to make a detailed investigation of the "oases" of life at the outlets of the underwater hydrotherms at depths 2-3 km. Quite recently a report was published about the descents of the French research submarine Nautilus to depths 6,000 m in the area of the Japan and Kuril-Kamchatka trench [Laubier et al., 1986]. There is no doubt that the future in the study of life at the greatest ocean depths belongs to this type of underwater vessel.

A completely new outlook was afforded by the use of so-called free vehicles that study the water mass and ocean bottom without having powerful winches on board the ship with an enormous supply of heavy cables. The free vehicle essentially means that a cable of several dozen or several hundred meters is lowered freely from the ship and a load and device (trigger) are attached to its lower end that at the requisite time releases the cable from this load at the acoustic command from the ship. The upper end of the cable has a float with a device that after the free vehicle floats to the surface begins to send various types of signals to allow the free vehicle to be found and brought on board the ship (Fig. 22). Between the float and the load on the cable, various instruments may be attached: current direction and velocity analyzers, inorganic and organic settling particle collectors, cameras to photograph the bottom or benthic water layer, bait for animals monitored by a camera, various animal traps, etc. [Phleger, Soutar, 1971; Dayton, Hessler, 1972; Hessler et al., 1972; Yayanos, 1977; Smith et al., 1979; Macdonald, Gilchrist, 1982; Lampitt, Burnham, 1983; et al.].

The largest Crustacea of the order Amphipoda were successfully found for the first time using bait monitored by a camera and lowered on a free vehicle. They were photographed at depth 5,300 m in the northeast Pacific Ocean, and they were 282 mm long which was twice as long as the largest previously known representatives of this order [Hessler et al., 1972]. The use of the free vehicle not only permitted observation on bait photographs of colossal clusters of Amphipoda Hirondellea gigas at the maximum depths of the Philippine and Mariana trenches, but also to catch them in bait traps lowered to the bottom of these trenches [Wolff, 1976a; Hessler et al., 1978]. As indicated by Hessler et al., from depths to 9,600 m in the Philippine trench the American expeditions used a box corer to obtain 13 samples and 8 catches by epibenthic sled. However they did not catch a single H. gigas. These crustaceans are apparently so mobile that they easily avoid the trap lines. Only by using photo-monitored bait and bait traps lowered on free vehicles can the largest representatives of the animal population in the benthic layers of the maximum depths of the hadal ocean trenches, the Philippine and Mariana, thus be detected.

Using satellite navigation to determine the location of a ship with high precision, search for and raising to the ship of a free vehicle floating on the surface now only takes about an hour or even less.

The animals that inhabit the abyssal depths, and even deeper, in the deep-sea trenches, do not withstand the pressure changes that occur when they are lifted to the surface, from several hundred to one atmosphere. They are therefore always dead when the catch is lifted onto the ship deck, despite the fact that due to the lack of any gas-filled cavities in their bodies they could remain externally completely undamaged.

Many questions related to the biology and physiology of deep-sea animals would be resolved if methods were developed to obtain the inhabitants of great depths alive and keep them under conditions close to their natural habitat. An experimental model of such an instrument rated for pressure to 1,000 atm has already been created for catching and bringing plankton organisms live to the surface [Macdonald, Gilchrist, 1969; Macdonald et al., 1972]. A special isobaric trap was recently developed that is lowered to the bottom on a free vehicle that can be sealed after catching bottom animals and allows them to be brought to the surface alive while maintaining the pressure at which they were caught. The use of this isobaric trap in 1980 permitted benthic Amphipoda to be caught and brought up from depths to 4,360, and then to conduct experiments for the impact on them of a pressure change [Macdonald, Gilchrist, 1982]. It is common knowledge that these isobaric traps have already been developed for their use at trench depths [Anonym., 1977; Yayanos, 1977], and the second of these publications mentions the catch in this trap of Amphipoda at depth 9,600 m in the Philippine trench.

There is no doubt that the new methods of research on benthic animals as developed in the last decades are promising, and the use of these methods to study animals inhabiting deep-sea trenches has already provided important results. However, in addition to the use of new methods (underwater photography, traps and bait lowered on free vehicles, the use of

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Figure 22. Diagram of Free Instrument Carrier

Key:
From left to right: descent, position on bottom, lifting

a. isobaric trap for amphipods
b. load remaining on the bottom
c. float system with signal sensors after surfacing
d. cable to which various instruments may be attached [per: Macdonald, Gilchrist, 1982]

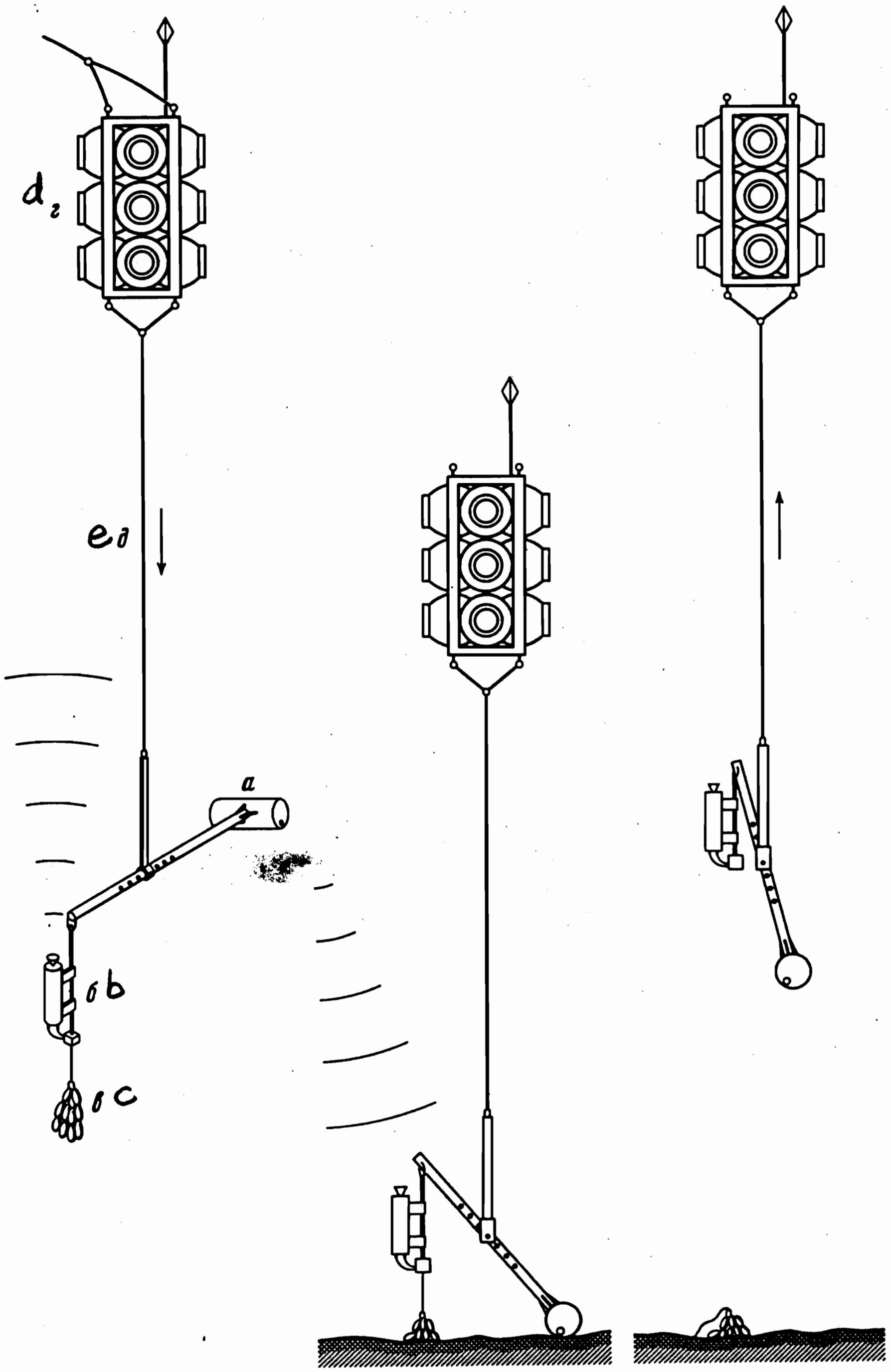

Рис. 22. Схема устройства автономного прибороносителя

Слева направо: спуск, положение на дне, подъем, *а* – изобарическая ловушка для амфипод; *б* – акустический приемник сигнала с судна для освобождения от груза; *в* – остающийся на дне груз; *г* – система поплавков с датчиками сигналов после всплытия; *д* – трос, к которому можно прикреплять различные приборы [по: Macdonald, Gilchrist, 1982]

manned underwater vehicles, etc.), the traditional research methods still maintain their importance: bottom grab and especially trawling collection by catching equipment lowered on a cable from a ship. The knowledge that has been accumulated by now regarding the precise taxonomic classification of the overwhelming majority of the animals populating the hadal depths is based on mass collections that were made by benthic sleds of various models lowered on a cable. It is precisely these collections that allow mass material to be obtained that is accessible for a detailed study by zoologists, specialists in various taxonomic animal groups, and for clarification of the precise classification of these animals. The latter is very necessary for research in other all-possible fields: study of different aspects of biology and ecology, physiology and biochemistry, geographical and vertical distributions, endemism, etc.

CHAPTER 4.
TAXONOMIC COMPOSITION OF THE ULTRA-ABYSSAL DWELLERS

Extensive data has already been processed on the ultra-abyssal fauna collected by expeditions from different countries. The results of fauna processing of the first two samples have been published that were obtained from depths over 6,000 m in the Atlantic Ocean by the expeditions on Princesse-Alice and Albatross-2. Processing and publication of the results of almost all taxonomic groups of animals presented in the collections from the hadal trenches of the Danish Galathea expedition have been completed.

Processing of the extremely extensive data collected during the 30 years of operation of Vityaz, as well as by the Soviet expeditions on the vessels Akademik Kurchatov and Dmitriy Mendeleyev has not yet been completed. But a lot of the collections have been processed and the findings have been published in dozens of articles of specialists in different taxonomic animal groups. Over 200 new species and over 30 new genera of animals encountered at depths over 6,000 m [Beliaev, 1983b] have already been described based only on the data from the Soviet expeditions on Vityaz.

Based on the data of the Japanese expeditions on Riofu-Maru, Soyo-Maru, Hakuho-Maru, Kayo-Maru and the American expeditions on Vema, Eltanin, Chain, Anton Bruun, John Elliott Pilsbury, Thomas Washington and Gillis mostly preliminary data and only some species or generic analyses of the animals collected in the deep-sea trenches have been published.

Despite the fact that the collected data has not yet been fully processed, the fauna lists of the animals inhabiting deeper than 6 km that have already been defined to species (although some of them have still not been described) already includes about 150 species of Protozoa and about 700 species of Metazoa, i.e., more than double in 20 years versus the last summary [Beliaev, 1966b; Belyaev, 1972].

In the lists cited in this work of the ultra-abyssal fauna for different taxonomic groups (Appendix II), new data were considered with final species analyses. In a number of cases, these data pinpoint or alter the preliminary analyses previously published, mainly in the publications of [Uschakov, 1952; Bruun, 1953a, b et al.; Zenkevitch et al., 1954, 1955; Beliaev et al., 1960; Wolff, 1960; Beliaev, 1966b; Belyaev, 1972]. This is the precise explanation for some discrepancies between the lists cited in this work and the preliminary publications.

In order not to overload the work with too many remarks, I will make no further stipulation of these in each specific case.

The lists also include previously published analyses of those new still undescribed species and determinations up to genus or family of animals whose more accurate taxonomic classification had not yet been established, as well as some yet unpublished definitions provided to me by specialists on various taxonomic groups.

BACTERIA

Before switching to a discussion of the taxonomic fauna composition in the ultra-abyssal depths, it should be noted that fairly diverse bacterial flora has been found at these depths. ZoBell [ZoBell, 1952; ZoBell, Morita, 1959], a participant in the Galathea expedition found various live bacteria in the sediment obtained from the bottom of the Philippine trench from depth over 10 km, as well as in the sediment from the trenches: Kermadec from depths 6,790-9,820 m, Yavan 7,020 m and Banda 7,250 m. The specific properties of these bacteria were their pressure-tolerance and temperature-sensitivity. Multiplication of ultra-abyssal bacteria under laboratory conditions primarily or exclusively occurred when pressure was maintained that was inherent to the depths from which these bacteria were taken (700-1,000 atm) and at low temperature (3-5°). The bacteria from these depths were morphologically similar to the standard soil and aquatic forms, but based on their physiological specific nature, C. ZoBell and R. Morita believe that they belong to new species and genera. The quantity of bacteria in the sediment may be very high, and apparently, they may play an important role in the feeding of the benthic fauna. The population of live bacteria in the sediment from depth over 10,000 m in the Philippine trench was 10^4-10^6 bacteria in 1 ml (cm^3).

The quantity of carbon contained in the live bacteria from the deep-sea benthic sediment taken by them from the dissolved or colloidal organic compounds, sea water, and to a lesser degree, from the settling detritus is 0.2- 2 mg per liter of sediment. The rate of reproduction of these bacteria is from 10 to 100 generations per year. Judging from these quantities, the bacteria may produce from 200 mg to 20 g of organic carbon per year in a ten-centimeter layer of sediment on an area of the bottom equal to one square meter, which could provide a considerable amount of food for the bottom-dwellers [ZoBell, Morita, 1959].

A considerable number of benthic heterotrophic bacteria were also found in the soil from depths over 6,000 m in a number of other Pacific Ocean trenches, Kuril-Kamchatka, Tonga, Peru and Chile, and in the Atlantic Ocean, South Sandwich trench [Kriss, Biryuzova, 1955; Kriss, 1959; Mitskevich, Kriss, 1971; Mitskevich, 1975].

Based on the data of R. Hessler et al. [1978], clusters of extremely numerous bacteria and their accompanying detritus were found on smears obtained from the intestinal contents of the Amphipoda Hirondellea gigas caught in traps in the Philippine trench at depth 9,600 m. Among the caught crustaceans, it was possible to distinguish those whose anterior part of the intestine contained particles of the bait (dead fish), both from the crustaceans with empty intestines, and from those that were trapped with an intestine (including its posterior part) that was already filled with a dark mass consisting of bacteria and particles of detritus. Based on the data from 965 specimens, crustaceans in the latter group averaged 60% in the smallest dimensional class (male-1 and female-1, length less than 20 mm), and with a increase in the crustacean size, this percentage dropped (inverse linear dependence); in individuals of the largest size class (females-6, length about 40 mm), the bacterial/detritus mass was encountered in less than 10% of the specimens. This mass consisted mainly of bacteria in many of the small specimens. Apparently, the established relationship indicates a shift in the feeding methods and food composition in the crustacean ontogenesis.

The bacteria found in the H. gigas intestine mainly belong to two morphological types, spherical and bacillary. Bacteria of only one type was invariably found in one crustacean. The authors discuss whether the Amphipoda swallow the bacteria together with the detritus on the bottom, or mass reproduction of the bacteria occurs in the intestine after the detritus is swallowed. In any case, however, there is no doubt that bacteria even at such great depths play an important role in the feeding of bottom-dwellers.

One of the greatest discoveries of our century is the detection in the last decade of oases of life related to the underwater hydrothermal springs at depths from 1.5 to 3 km in the ocean tectonic active rift zones. Directly next to the hydrothermal springs and on their neighboring bottom sections, unusually abundant and diverse communities of benthic animals live, which for the most part are classified as new species, genera, and sometimes new taxons of a higher class previously unknown to science. Some of these animals reach giant dimensions, e.g., Riftia pachyptila from the Pogonophora Vestimentifera class (tube up to 3 m in length, and body size up to 1.5 m) or bivalve mollusks Calyptogena magnifica , up to a quarter of a meter in length. The biomass in the areas of accumulations of these animals could be several kg, and even tens of kg per 1 square meter of the bottom. Similar levels were previously known only for shallows in the most productive ocean regions, while at depths 2-3 km the benthic biomass usually does not exceed several grams or several dozen grams per square meter [Zenkevitch et al., 1971; Beliaev, 1985c].

It has been established that this abundant life does not exist because of organic substances coming to the bottom from the surface ocean layers, and in the final analysis owes its origin to phytoplankton photosynthesis, and local autochemosynthesis of the bacteria that exist in enormous quantities in the waters of the hydrothermal layer and near it. These bacteria synthesize organic matter of their bodies, using the energy released during oxidation by them of various reduced compounds taken from the Earth's depths with the hydrothermal water (hydrogen sulfide, methane, ammonia gas, etc.), and the carbon dioxide of the surrounding sea water. There have been descriptions of clusters of such bacteria that form mats on the bottom not only near the hydrothermal springs, but also in the areas of seepage from the depths of cold water that also contains hydrogen sulfide or methane of thermal origin. The local primary product created by these bacteria is the initial food source for those animals that comprise the community of these deep-sea life oases. Moreover, the symbiotic clusters of these bacteria exist in the tissues of a number of animals inhabiting these oases (e.g., the trophosome tissue, a special section of the rift dwellers, or gills of Calyptogena) and life products of such bacteria, and possibly, they themselves could serve as food for their hosts. There have been extensive publications on life in the hydrothermal regions, therefore here I will only cite several works [Corliss, Ballard, 1977; Ballard, Grassle, 1979; Oceanus, 1984; Jones, 1985].

Until recently, these life oases were mainly known from the regions of hydrothermal springs in the rift zones of the Pacific and Atlantic Oceans from depths no more than 3 km. Extremely interesting reports have recently been published, however, [Lallemant et al., 1986; Laubier et al., 1986] about finding similar oases at a depth of about 6,000 m.

During the 1985 summer work of the French-Japanese expedition of the research submarine Nautile, numerous deep-sea submersions were made at the Pacific Ocean coasts of Japan in the subduction zone between 33 and 41°20 n.l.. During seven of these descents at depths from 3,800 to 5,960 m, exceptionally abundant communities were found on the bottom that mainly consisted of Calyptogena mollusk clusters (three new types), as well as other animals accompanying them. Thus, for example, during descents in the Japan trench and in the junction area of the Japan and Kuril-Kamchatka trenches at depths over 5,600 m and at 5,900 m, the density of mollusk clusters, converted per unit of area was 400, 700 and 1,500 specimens/m^2, and their biomass, was respectively 24, 42 and 51 kg/m^2 (!). The benthic biomass at these depths in this part of the ocean is usually no more than several g/m^2, based on Soviet expedition data (see, e.g.: [Beliaev, 1960, 1966b, 1985c]).

No hot water springs were found in the regions of such oases, but the water temperature washing over the mollusk colonies was 0.2-0.6° higher than in the neighboring regions where it was 1.2°C. Geochemical analyses of the water samples taken at the sites of mollusk clusters indicated the presence of interstitial seepage water containing thermogenic methane, the source of energy for bacterial chemosynthesis whose products are the reason for existence of these mollusk clusters and the animals that accompany them [Laubier et al., 1986; Lalleman et al., 1986].

It is quite likely that when research submarines are designed that are capable of active search at any depths, similar oases of life will be detected at even greater depths of many trenches, insofar as the latter are confined to tectonic active zones where the possible existence of thermal water springs is so likely.

It is important that Lemche et al. repeatedly found on the color stereoscopic photographs of the bottom of the Bougainville, New Britain and Palau trenches obtained at depths from 7 to 8.5 km dark spots delimited from the surrounding lighter bottom, that apparently are bacterial films. Judging by certain photographs, these films are partially destroyed apparently by the organisms feeding on them, e.g., Pseudopoda, Xenophoridae, Holothurioidea, etc. [Lemche et al., 1976].

PROTOZOA
RHIZOPODA
FORAMINIFERA

Foraminifera were detected at all depths, up to depth 10,415-10,687 m in the Tonga trench [Beliaev et al., 1960]. At depths over 6,000 m they were first found by the Challenger expedition in a sample obtained by a sounding tube in the Japan trench [Brady, 1984], and further by the Vityaz and Akademik Kurchatov in many trenches and troughs of the Pacific Ocean, in the Yavan and South Sandwich trenches [Zenkevitch et al., 1955; Shchedrina, 1958; Beliaev et al., 1960; Beliaev, Vinogradova, 1961a; Saidova, 1961, 1964, 1969, 1970, 1975, 1976; Khusid, 1973, 1977, 1984; Basov, 1974, 1975], expeditions on Eltanin in the Peru trench [Menzies, 1963, 1964; Bandy, Rodolfo, 1964] and on the research vessel Thomas Washington in the Aleutian trench [Jumars, Hessler, 1976]. Foraminifera were also observed on bottom photographs taken in the New Britain trench at depth over 8 km [Lemche et al., 1976].

The number of species (more precisely, the species names) of Foraminifera that were defined by different authors in collections from depths exceeding 6,000 m already approach two hundred, i.e., exceed the number of species known from such depths of any class of multi-celled animals, except the crustaceans. It would seem that the example of the Foraminifera could be the best tracking of the laws governing their vertical distribution in the ultra-abyssal, geographical dissemination in the trenches of various ocean regions and the link between the fauna of different trenches. However, for a number of reasons, the data on this group was not very suitable for such an analysis and only some generalized conclusions can be drawn about the features of the Foraminifera fauna in the ultra-abyssal zone as a whole.

V. A. Dogel' [1951], in discussing the appearance of the Foraminifera, noted the extreme indistinctness of their distinguishing features and their color changes even in different genera, which significantly impairs identification of different forms. Dogel' indicates that the number of Foraminifera genera known by that time (including the fossil forms) was about 700, while the number of species names proposed by various authors reached 9,000.

The situation with this group has become even more complicated in recent years. The article pessimistically entitled "Twilight of Foraminiferology" by E. Boltovskoy [1965] cites amazing data about the confusion and chaos reigning in the taxonomy of benthic Forminifera. In only a few cases the same species names are used throughout for the same species, but even in these instances there is no uniformity in the generic names. At best, one can only name several dozen species that can be unequivocally defined in different laboratories. In the American National Museum alone, the species Nonion affine was catalogued under 11 different names, of which 5 belonged to new species [Boltovskoy, 1958]. The increment in "new" species of this group in the 1950's averaged about three daily, and in the majority of cases, these species were invalid. By 1965, the number of Foraminifera species names had already reached 30,000, and the genera exceeded 1,700. Boltovskoy believes that at least 25,000 of these 30,000 "species" are invalid. It is true that all of this primarily refers to fossil species or shallow-water species from the modern. The deep-sea fauna, and especially the fauna of the greatest depths have been studied incomparably less than the shallow-water species, and it is natural that many valid new species may be encountered when it is studied, nevertheless, the history of Foraminifera study in the hadal ocean depths could serve as an illustration of Boltovskoy's pessimistic statements.

The situation is complicated even more by the fact that until recently the researchers who were analyzing the deep-sea benthic Foraminifera almost always had collections that did not separate the Foraminifera that were collected live from their empty shells. The latter could be partially at great depths in the secondary depth as a result of drift from shallower depths or as a result of movement of the shells not only of modern, but also dead species after washing away of the buried sediment.

The sample obtained by Challenger from a depth of 7,220 m in the Japan trench [Brady, 1884] revealed 14 species of Foraminifera. According to Brady's analysis, all of these Foraminifera belonged to already known and widespread eurybathic species.

Further information about the composition of Foraminifera detected deeper than 6,000 m did not appear until the publication of Z. G. Shchedrina [1958] of the Vityaz collection processing results in 1949 and 1953 in the area of the Kuril-Kamchatka trench, including at five stations at depths from 6,860 to 9,050 m. Shchedrina found 28 species below 6,000 m. Only one of them (new species of the genus Miliolin) belonged to Foraminifera with a secretion and not agglutinated shell. Eight species (about 30%) were new, and 7 of them were only found below 8,000 m. Twenty species were characterized by more or less broad dissemination. Unfortunately, the new species found by Shchedrina have not been described, and the question of their identity with species of subsequent collections in the same trench is still unanswered.

A number of subsequent works that cover the Pacific Ocean Foraminifera, including those in various deep-sea trenches, were published by Kh. M. Saidova [1961, 1964, 1969, 1970, 1975], and the refined list of Kh. M. Saidova [Beliaev, 1966b]. However, as Saidova processed the materials, the composition of the Foraminifera defined in them from depths over 6,000 m changed so much (the change in the volume of species, species names, generic classification of the same species, and sometimes even their classification to different families and even orders) that the compilation of a unified, common list with precise data on the vertical and geographical distribution of the species was essentially impossible.

In her last summary, Saidova [1975] in the overall list of species of benthic Foraminifera found in the Pacific Ocean for depths over 6,000 m indicates over 103 species (Appendix II, Table 1), among which 57 have been described by Saidova as new (in this or earlier publications). Endemic animals of depths over 6,000 m number 18 (less than 20%). Only 4 species belong to Foraminifera with secretion, lime shell of the order Miliolida (in her 1976 publication, Saidova adds to it another 2 species from the order Rotaliida), 2 with organic shell from the order Allogromida, and all the rest belong to different groups of Foraminifera with agglutinated shell.

Foraminifera were studied in the Peru trench from two trawling samples obtained on the Eltanin expedition (stations 37 and 35) from depths 6,006 and 6,250 m [Bandy, Rodolfo, 1964]. The list of Foraminifera from these stations includes 19 species, among which, as deeper than 6,000 m in other regions of the Pacific Ocean, there is rarely a predominance of forms with agglutinated shell (15 out of 19 species and 99% by population) that belong to the same families as in other trenches. However, there are no common species names from Saidova's list [1975] for the entire Pacific Ocean, nor with the lists of T. A. Khusid for the Aleutian (Appendix II, Table 2) and for the Chile [Khusid, 1977, 1984] trenches in the list of Bandy and Rodolfo. It is unfortunately impossible to judge to which measure this discrepancy in the species reflects the actual specific nature of the Foraminifera fauna of various regions or is the result of inadequate analyses made by different authors. Bandy and Rodolfo did not find any species endemic to depths over 6,000 m, which is understandable if one considers that the samples were only obtained from depths to 6,250 m. For the trawling sample obtained in the Chile trench from depth 7,720 m (Akademik Kurchatov, st. 244), Khusid [1977, 1984] notes 7 species (6 from the order Astrorhizida and 1 from the family Komokiidae of the order Testulariida, defined only to the genus Normanina sp.). Of the 6 species of Astrorhizida, 5 were previously known from bathyal depths, and only one new one, endemic for this trench (Thurammina decimana Khusid).

Among the 29 species noted by Khursid [1973] for depths 6,500-7,000 m of the Aleutian trench, there were no endemic species. It is true that 9 of the 29 species have only been defined to the genera and it has not been excluded that there could be new species among them.

As for the Foraminifera defined from the surface layer of the sediment column taken by Eltanin (st. 79) in the Chile trench at depth 6,011 m [Bandy, Rodolfo, 1964], the overwhelming majority belong to the shallower deep-sea forms with secretion shell (37 of 42 species and 96% by population), clearly brought from shallower depths (see: [Beliaev, 1966b]), and they should not be included in the Foraminifera fauna dwelling deeper than 6,000 m.

Brief information about Foraminifera from one sample obtained from the South Sandwich trench (Akademik Kurchatov, st. 895, depth 6,875 m) is given in the works of I. A. Basov [1974, 1975]. Basov indicates that this sample contained 13 species, of which he only names five: Hyperammina laevigata (Wright), Proteanella minuta Saidova, Rhabdammina abyssorum Sars from the order Astrorhizida, Conotrochammina abyssorum Saidova, and Trochammina sp. from the order Atazophragmiida. Judging from the graph [Basov, 1975, Fig. 1], among the other species there were 1 or 2 species with secretion shell, but their population was only about 1%. The total Foraminifera population in this sample was 344,000 specimens/m^2. Of the five listed species, one (P. minuta) was previously only known from depth 8,220-9,220 m in the Kuril-Kamchatka trench. Yet another species, Trochammina sp. in the discussed sample comprised about 50% of the population. Judging from the fact that it was only defined to the genus, it may be assumed that this is a new species that is possibly endemic for the South Sandwich trench. Basov [1975] and Saidov [1976] note that the Foraminifera with secretion (lime) shell at depths over 6,000 m are only found alive, since the remaining hollow shells are rapidly dissolved.

As I have already mentioned, numerous Foraminifera of the order Allogromida [Jumars, Hessler, 1976] were found in the sample obtained by a box corer at depths over 7 km in the Aleutian trench.

No other information has been published about the Foraminifera composition from the deep-sea trenches (with the exception of data on the superfamily Komokiacea, discussed below).

Despite the stipulations regarding the difficulties of an objective evaluation of the Foraminifera data, it may be noted that there is a considerable similarity between the group composition of the Foraminifera ultra-abyssal fauna based on the data of various authors.

In the northern and western Pacific Ocean trenches, only a few species of Foraminifera have been found with secretion lime shell, mainly from the order Miliolida, and in the Peru trench at depth 6,250 m only two species from the same order and two species from the order Rotaliida have been found. Singular species of the order Allogromida with soft shell made of organic material were also noted for the northern Pacific Ocean [Saidova, 1975; Jumars, Hessler, 1976].

All the other species are classified as Foraminifera with agglutinated shell, averaging 90% based on the data of different authors. All the lists have a predominance of species of the order Astrorhizida (averaging 45%); from 20 to 40% (averaging 25%) there are species of the order Ammodiscida, and an average of 10% of the order Ataxophragmiida. This coincidence may undoubtedly be random. For the overwhelming group composition of Foraminifera, Saidova isolates depths over 6,000 m as the Astrorhizda zone. Khusid [1977] in the Chile trench isolates the biocenoses Sorosphaera abyssorum-Thurammina decimana for depth 7,720 m. These two species (both from the order Astrorhizida) comprise two thirds of the total population here of the Foraminifera with total population density of live creatures 15,000 specimens/m^2.

It is important that the Foraminifera of the two most widely representated orders in the abyssal and ultra-abyssal are the most ancient and archaic [Fursenko, 1950; Dogel', 1951]. It is possible that representatives of these groups inhabited the ocean depths back in ancient times and these deep-sea forms were the main genetic pool for deeper depths of the ocean trenches as the latter were formed. These orders include 90% of the species that are endemic for depths over 6,000 m.

Species with a broad vertical dissemination dominate in the Forminifera that penetrate to the hadal ocean depths. The upper habitat boundary of almost 60% of the species is confined to the bathyal depths and 24% to the abyssal (3,000-6,000 m). The species that are endemic for depths over 6,000 m, judging by Saidova's list [1975], are only 17%. However, as the depth increases beyond 6,000 m, in addition to the overall decrease in the number of species, the degree of fauna taxonomity increases. Of the 26 species encountered deeper at 8,000 m, already 46% are endemic for depths over 6,000 m, and 31% do not rise above 8 km.

The species that are endemic for any one trench are encountered in the Kuril-Kamchatka, Kermadec, Bougainville and Chile trenches. Species that live at shallower depths are for the most part common for several trenches. But two new species described by Saidova (Recurvoidatus ultraabyssalicus and Recurvoides mutilus) were only encountered in several trenches separated from each other and unknown from depths less than 6,500 m, while the species Proteanalla minuta, as already mentioned, is only known from depths over 6,800 m from the Kuril-Kamchatka and South Sandwich trenches.

There are three known endemic genera in the ultra-abyssal Foraminifera fauna, Xenothekella (habitat depth 9,170-9,335 m), Astrorhinella (6,860-7,320 m) and Cribostomellus (8,220-9,850 m). These three genera were established by Saidova [1975]. All of them are monotypical, and their dissemination is limited to the Kuril-Kamchatka trench.

The boundary of the ultra-abyssal zone for Foraminifera fauna should apparently be made somewhat below 6 km insofar as it is precisely at the 6-6.5 km level that there is a shallower boundary of dissemination of half of the species that are known below 6,000 m, and at shallower depths.

Data about the extremely high quantitative indicators (population and biomass) of the benthic Foraminifera at all ocean depths have appeared in recent decades after the development of the technique for separation in the mass samples of live Foraminifera from the their empty shells. Based on the data of Saidova, the number of live Foraminifera at depths over 6 km in the Kuril-Kamchatka trench fluctuated from 20,000 to 95,000 specimens/m^2, and their biomass plasma (without shell weight), from 2 to 10 g/m^2 [Zenkevitch, 1967; Saidova, 1970]. The biomass of Forminifera is just as great (10 g/m^2) also in the Chile trench at depth over 7.5 km [Saidova, 1971]. However, these data are apparently very exaggerated since later publications of other authors indicate shallower levels. Thus, per the data of Khusid [1977] obtained on the same materials, the biomass of live Foraminifera (and not only their plasma) in the Chile trench is 1 g/m^2; in the Aleutian trench at depths up to 6,980 it fluctuates from 0.1 to 2.1 g/m^2, and in the South Sandwich at depth 6,875 m was 0.09 g/m^2 [Basov, 1974, 1975].

Despite the fact that the data of different authors regarding the Foraminifera biomass are far from unequivocal, there is no doubt that the Foraminifera play a very significant role in the deep-sea trenches in the diet of the benthic soil-eating forms. The concept of the importance of Foraminifera in the deep-sea benthos diet increases even more, if one considers the exceptionally important data of O. Tendal and R. Hessler [1977] cited in their monograph that covers the new sub-family of Foraminifera that they established, Komokiacea (order Textulariida).

Many, predominantly deep-sea expeditions by a number of countries that have been conducted in the last three decades often encountered in the trawling, and especially, in the bottom-grab samples, small (from 1 to 5 mm) formations that are a varying form of clusters made of branching, thread-like tubules that form complex networks. The space between the tubules is usually filled with silt benthic sediment, often even covering the surface of the cluster. It became the practice in the field logs by the Soviet expeditions on the vessels Vityaz and Akademik Kurchatov to give these formations the conventional designation "branching clusters". For a long time their nature was unknown. As Tendal and Hessler write, during examination of the samples they were generally ignored and it was assumed that they were fibers encrusted with soil.

Using histological methods and an electron scanning microscope, Tendal and Hessler have only studied a small part of the numerous specimens sent to them from different countries, including from the Soviet expeditions. These authors have quite definitively established the affiliation of the "branching clusters" to a special sub-family of Foraminifera that they have called Komokiacea, the Latin derivative from the Russian word for "cluster" (Fig. 23). These authors have isolated two families, Komokiidae with five genera and seven species (Ipoa fragila, Komokia multiramosa, Lana neglecta, L. reticulata, Normanina saidovae, N. tilota and Septum octotilla) and Baculellidae with two genera and four species (Baculella globifera, B. hirsuta, Edgertonia argillispherula, E. tolerans). Only the genus Normanina was previously known from this group, while all the other genera and all the species were established by Tendal and Hessler for the first time. Descriptions of all these species are based on the specimens obtained in one trawling sample obtained in 1970 by the American expedition on the vessel Thomas Washington[1] from depth 6,065-6,079 m in the northeast trench of the Pacific Ocean (st. H-30) (Fig. 23). Additionally, based on the data of the same authors, Komokiacea were found deeper than 6 km that were defined only to the genus in the Aleutian (Thomas Washington, st. H-39, 7,298 m, Lana sp.) and Puerto Rico trenches (Akademik Kurchatov, two stations 6,650-8,100 m, Ipoa sp 2 stations 7,950-8,150 m, Edgertonia sp; 8,150 m, Baculella sp.). The greatest depth of finding Komokiacea was 9,605 m in the Philippine trench (Thomas Washington, st. H-189 and H-196) (closer was not defined). All the genera of Komokiacea known until this time were widespread in the ocean abyssals, and some are known from the bathyal depths.

Tendal and Hessler write that the study of this group has only just begun. In characterizing the unusual abundance and species diversity of the Komokiacea, they cite data that from a single 500 cm^2 area that corresponds to one-fifth of the sample obtained by the box-corer from the northeast trench of the Pacific Ocean from depth

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[1] It is erroneously indicated in the cited monograph [Tendal, Hessler, 1977] that the samples at stations H-30 and H-39 were obtained by the research vessel Argo in 1969. Precise data about these stations are cited in the works of Hessler and Jumars [Hessler, Jumars, 1974; Jumars, Hessler, 1976] (see Appendix I).

Figure 23. Komokiacea

Key:
A. Edgertonia argillispherula; B. Normanina saidovae; C. Baculella hirsuta; D. Lana neglecta (per: Tendal, Hessler, 1977)

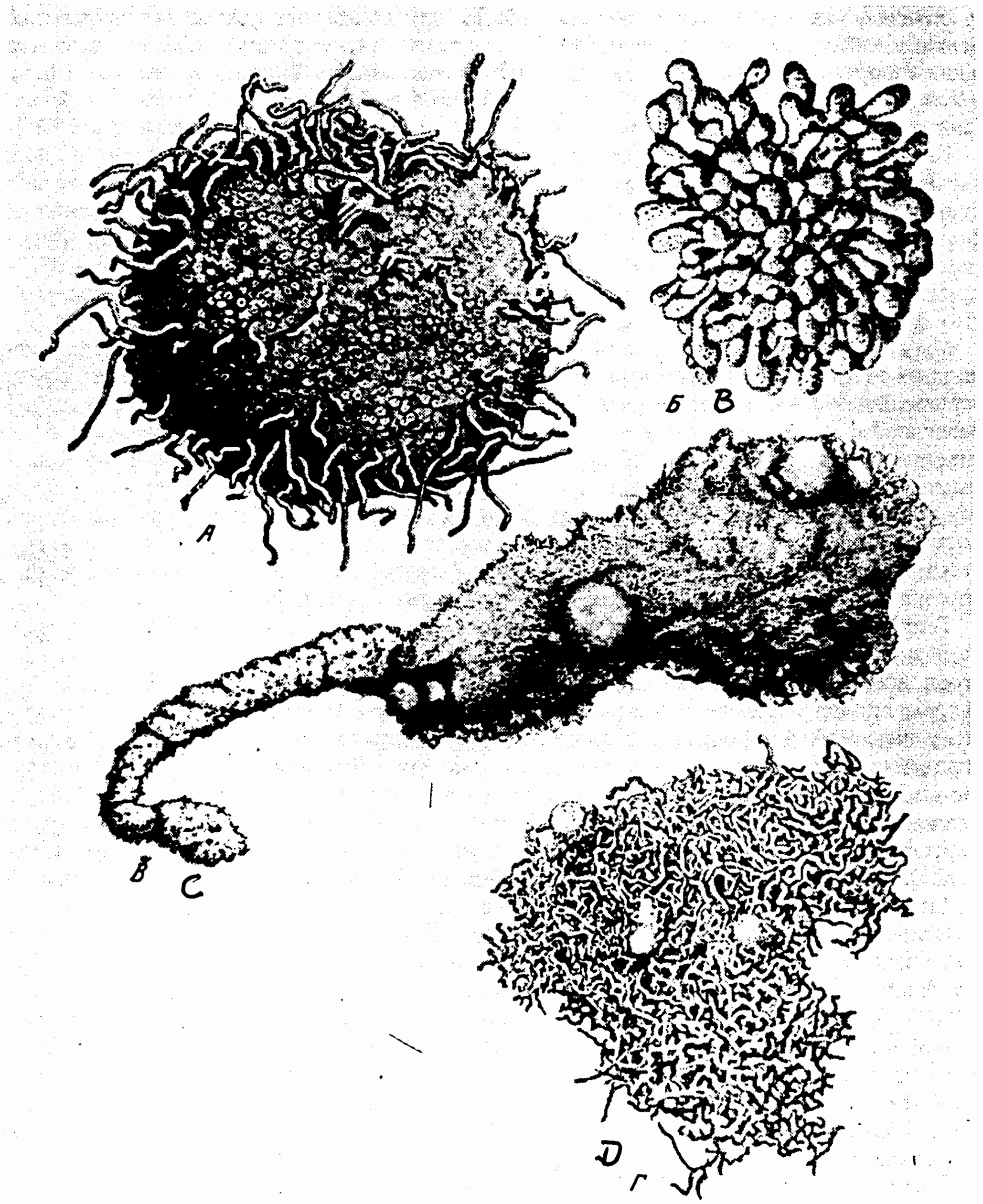

Рис. 23. Komokiacea

А – Edgertonia argillispherula; *Б* – Normanina saidovae; *В* – Baculella hirsuta; *Г* – Lana neglecta (по: Tendal, Hessler, 1977)

5597 м ("Томас Вашингтон", ст. Н-153, 21°26′с.ш., 155°30′з.д.), были обнаружены 56 видов и 1984 экз. этих фораминифер, из которых более 80% были приурочены к верхнему слою осадка толщиной 1 см. Обшее же число видов этой группы, по их мнению, видимо, составляет несколько сотен. Комокиацей можно обнаружить практически в каждой глубоководной донной пробе, а в пробах с абиссальных глубин олиготрофных районов океана и в пробах из глубоководных желобов (например, на глубине 9600 м

5,597 m (Thomas Washington, st. H-153, 21°26', n.l., 155°30' w.l.), 56 species were found and 1,984 specimens of these Forminifera, of which more than 80% were confined to the upper sediment layer of thickness 1 cm. It was of their opinion that the total number of species in this group is apparently several hundred. Komokiacea can be found essentially in every deep-sea benthic sample, and in samples from sub-abyssal depths of the oligotrphic ocean regions and in samples from deep-sea trenches (e.g., at depth 9,600 m in the Philippine trench) "their volumes exceed that of all the Metazoa taken together" (Ibid, p. 193).[1]

These data permit the assumption that the Komokiacea should play a major role in the diet of the benthic invertebrates dwelling in the deeo-sea trenches.

XENOPHYOPHORIA

Protozoa of yet another group, Xenophyophoria, play a major role in the dep-sea benthos. These remarkable animals, which sometimes look like leaf-like forms lying on the ground surface could reach 20-25 cm in diameter and thickness 1-2 mm. They were first found in the 1870's by an expedition on Challenger and were described by E. Haeckel [1889] as sponges of a special group of Keratozoa. Their real taxonomic position for almost a century remained indefinite, however, various studies classified them as Spongia, or different groups of Protozoa , most often Foraminifera.

Based on a review of numerous previously known data, as well as a study of extensive materials collected by expeditions in the last decades (mainly, numerous deep-sea collections by the Danish Galathea expeditions and the Soviet Vityaz expeditions), O. Tendal in his monograph [1972] that covered these enigmatic animals established that they are Sarcodina of the Rhizopoda class, and isolated them into a special sub-class Xenophyophoria, close to the Foraminifera sub-class.

Xenophyophoria are widespread in the World Ocean from the shallows to the ultra-abyssal depths, but they are the most numerous and diverse at the abyssal depths of the ocean floor. Tendal established two orders in the sub-class Xenophyophoria, Psamminida and Stannomida. The first of them contains 4 families, 8 genera and 20 species, while the second contains a single family, Stannomidae with two genera, Stannoma (2 species) and Stannophyllum (13 species). The predominantly abyssal genus Stannophyllum known from a single finding from bathyal depths and even from shallow water, also includes two species that were found both in the abyssal, and deeper than 6 km [Tendal, 1972; Tendal, 1973]. Tendal knew S. granularium from the Kuril-Kamchatka trench (Vityaz, st. 5,617 and 5,625, 6,215 and 6,710 m) and from the northwest trough of the Pacific Ocean (Vityaz, st. 3,232 and 3,363, 6,116-6,282 m), as well as from the north and west Pacific Ocean, starting from depth 4,365 m. Tendal found S. mollum in the Japan trench (Vityaz, st. 3,593, 6,380 m) and it is also known from the Indian Ocean and northwest part of the Pacific Ocean from depths over 4,700 m. Xenophyophoria have also been found on many photographs of the bottom that were taken in four trenches of the western tropical section of the Pacific Ocean (Palau, New Britain, Bougainville and New Hebrides) at depths to 8,662 m [Lemche et al., 1976]. It should be noted that O. Tendal was among the group of authors who studied these photographs which indicates the high reliability of the Xenophyophoria analyses made from these photos. I will cite some information about the Xenophyophoria stressed in this work.

Representatives of the genus Psammetta have been found in three deep-sea trenches. They are spherical, reach 2-5 cm in cross-section and are usually surrounded by "threads" diverging from the main body in a star shape (Fig. 24), reaching lengths of 6-12 cm, and apparently, are Pseudopoda. These organisms are usually found in soft ground and form clusters that are separated by bottom sections on which they are absent. At depths slightly less than 8 km in the New Britain trench, Psammetta sp. were found on 325 photographs, and their mean density was 1 specimen/m^2. The mean density calculated by the photographs

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[1] The authors apparently mean only the Metazoa of the meiobenthos from the bottom-grab samples.

Figure 24. Xenophyophoria Psammetta sp. on Floor of New Britain Trench at Depth 7,900 m [per Lemche et al., 1976]

of the Xenophyophoria of genus Stannpohyllum was 1 specimen per 3 m^2 in the New Britain trench at depth 8,260 m, and in the New Hebrides at depth 6,770 m 1 specimen at 10 m^2. Xenophyophoria of another genus were encountered more rarely, Cerelasma; based on the photographs obtained below 8 km in the Bougainville trench, the average density of their populations was about 3 specimens per 100 m^2.

Xenophyophoria previously were not taken into account as live organisms and were ignored in the determination of the biomass of the deep-sea benthos from dredging samples. However, based on the data of the trip of the research vessel Akademik Kurchatov in 1986, in the abyssal of the southern Atlantic Ocean the biomass of Xenophyophoria could significantly exceed the biomass of all other animals in the dredging samples. L. A. Levin et al. [1986] demonstrated that at depths up to 3,350 m large Xenophyophoria play an important role in the communities of the soft soil and serve as a substrate, food and shelter for various Metazoa.

It may be hypothesized that in the deep-sea trenches Xenophyophoria play a very significant role in the primary use and reprocessing of the organic matter contained in the benthic sediment, and correspondingly in the nutrition of various benthic Metazoa animals.

METAZOA

SPONGIA

At depths over 6,000 m representatives of two classes of Spongia are encountered, the class Hyalospongia and the class Demospongia, represented at these depths almost exclusively by the order Cornacuspongida; from the second order of this class (Textraxonida) only one species is known that was found at depth 6,065 m in the northeast trench of the Pacific Ocean. Spongia are found in the Pacific Ocean in 17 trenches, but the species analyses are only known for 18 species from the Aleutian, Kuril-Kamchatka, Bougainville and Kermadec trenches, as well as from depths slightly over 6 km in the northwest and northeast troughes. Five of these

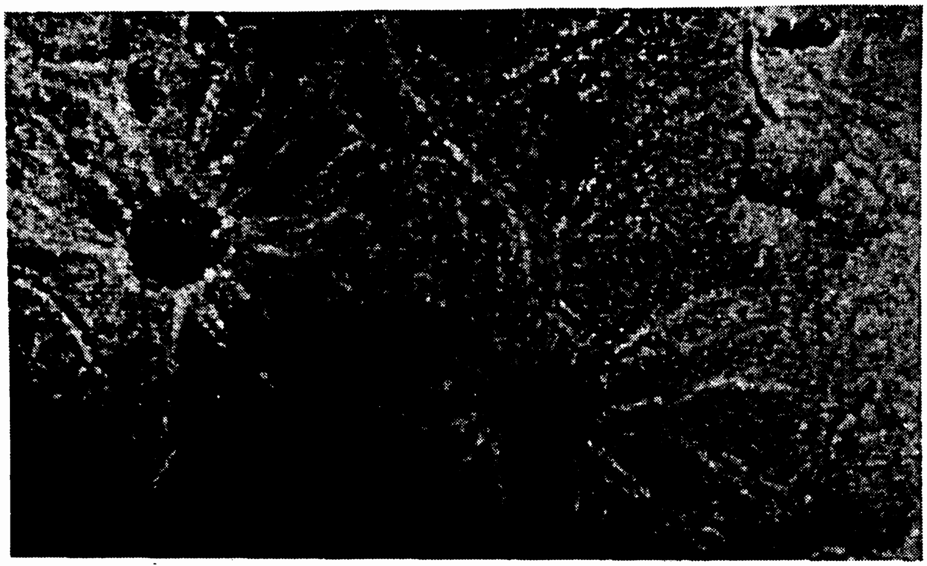

Рис. 24. Ксенофиофоры Psammetta sp. на дне Ново-Британского желоба на глубине 7900 м [по: Lemche et al., 1976]

ксенофиофор рода Stannophyllum была в Ново-Британском желобе на глубине 8260 м 1 экз. на 3 м^2, а в Ново-Гебридском на глубине 6770 м 1 экз. на 10 м^2. Значительно реже встречались ксенофиофоры еще одного рода – Cerelasma; по фотографиям, полученным на глубине более 8 км в Бугенвильском желобе, средняя плотность их поселений составляла около 3 экз. на 100 м^2.

Ранее ксенофиофоры часто не принимались во внимание в качестве живых организмов и не учитывались при определении биомассы глубоководного бентоса по дночерпательным пробам. Однако по материалам проходившего в 1986 г. рейса э/с "Академик Курчатов", в абиссали южной части Атлантического океана биомасса ксенофиофор может значительно превышать биомассу всех других животных в дночерпательных пробах. Л.А. Левин с соавторами [Levin et al., 1986] показали, что на глубинах до 3350 м крупные ксенофиофоры играют важную роль в сообществах мягких грунтов и служат для различных многоклеточных животных субстратом, пищей и убежищем.

Можно предполагать, что и в глубоководных желобах ксенофиофоры играют весьма значительную роль в первичном использовании и переработке органики, содержащейся в донных осадках, и соответственно в питании различных донных многоклеточных животных.

МНОГОКЛЕТОЧНЫЕ – METAZOA

ГУБКИ – SPONGIA

На глубинах более 6000 м встречены представители двух классов губок – класса стеклянных губок Hyalospongia и класса Demospongia, представленного на этих глубинах почти исключительно кремнероговыми губками (отряд Cornacuspongida); из второго отряда этого класса (Tetraxonida) известен лишь один вид, найденный на глубине 6065 м в Северо-восточной котловине Тихого океана. В Тихом океане губки найдены в 17 желобах, но видовые определения пока известны лишь для 18 видов из желобов Алеутского, Курило-Камчатского, Бугенвильского и Кермадек, а также с глубин немногим более 6 км в Северо-западной и Северо-восточной котловинах. Пять из этих

species belong to four genera and families of both orders of Hyalospongia, and 13 to six genera of five families of both orders of the class Demospongia. Another several species from different Pacific Ocean trenches have only been defined to the genus or the family level. Undefined Hyalospongia or Cornacuspongida have also been found in three Atlantic Ocean trenches. Spongia have been found by now in trawling nets obtained at approximately 45 stations by various expeditions, mainly by the expeditions on Vityaz. However, the systematic processing of a considerable portion of these materials has not yet been completed (Appendix II, Table 3).

Below 2,000 m in the Pacific Ocean, 109 species of Spongia were known by 1970 [Koltun, 1969, 1970]. The species in the composition of this fauna penetrating below 6,000 m comprise about 17%. Their taxonomic composition is very variegated. Of the 10 genera represented at these depths, none of them includes more than three ultra-abyssal species. Only two species are known that are endemic for depths over 6,000 m (each from a single finding), 11% of all the species encountered at these depths. Among the Spongia dwelling deeper than 6,000 m there is a predominance of abyssal species that do not rise above 3,000-5,000 m (44%). The species that dwell in the bathyal comprise 28%, and 17% from those known from depths less than 500 m. Only three from the already defined species were found below 8 km. The majority of the species encountered in the trenches does not penetrate deeper than 6,500 or 7,000 m. As V. M. Koltun [1970] notes, the ultra-abyssal Spongia fauna is a depleted fauna of the abyssal depths.

Three new species from the Kermadec trench [Levi, 1964] have been defined in the already completely processed collections from the Galathea expedition, but one of them, Asbestopluma hadalis, was subsequently classified with the synonomy of the eurybathic species A. occidentalis [Koltun, 1970]. The last, known hadal Spongia species, was found at depth about 7 km in the Kermadec trench and at several stations in the Kuril-Kamchatka trench in the depth range from 7,265 to 8,840 m. However, this same species, based on V. M. Koltun's data [1970], is known in the Pacific Ocean northern section and from abyssal and bathyal depths, starting from 820 m.

Because there are no Spongia at the hadal depths of the Kuril-Kamchatka trench, V. M. Koltun [1970] advanced the opinion that penetration of the Spongia to the maximum depths of the trench floor is prevented by the dominance here of silt: the presence on the bottom of numerous suspended silt particles results in clogging of the Spongia irrigation system and their death. Koltun also considers the shortage of solid substrates for attachment on the bottom to be an obstacle to a Spongia habitat. Based on this, he advanced the hypothesis that in the deepest trenches (Mariana, Philippine, Tonga and Kermadec) the depth of dissemination of the Spongia may be somewhat greater than in the Kuril-Kamchatka, since the Spongia in these trenches may descend lower on their slopes without reaching the very silted floor. This hypothesis was seemingly confirmed by the result of the 1970 trawling in the Tonga trench when from depth 8,950-9,020 m several small Spongia (not yet defined) were raised with other animals. However, in 1975 Vityaz found single Spongia defined by Koltun as Asbestopluma sp. in the Philippine trench all the way to depth 9,990 m, only by less than 300 m reaching the maximum depth of this trench, i.e., essentially confined to its floor. Thus, the dissemination of Spongia in the trenches is apparently determined not by the depth, but by the presence at any depths of ecological niches related to the nature of the bottom microrelief that are favorable for the existence of the Spongia.

Although fairly diverse Spongia inhabit many trenches, very few of them usually dwell here, most often single specimens are found in the catches. It is indicative that in analyzing the animals on approximately 4,000 photographs of the bottom obtained in five trenches of the Pacific Ocean western tropical section, Spongia (apparently, Cornacuspongida belonging to the Cladorhizidae family) were only found on three photographs from the Palau trench and on six from the New Britain trench [Lemche et al., 1976].

There are only three known instances of mass finding of Spongia from depths over 6,000 m. In the Pacific Ocean northeast trough (on the east slope of the Imperator trench) in the trawling catch (Vityaz, st. 3363, 6272-6282 m) there were 207 specimens of five Spongia species, in which 200 specimens were of one species, Hyalonema apertum [Koltun, 1970]. This was 12% of the total number of species in the take and 16% of the total number of animals caught. Such a massive number of Spongia at this depth is also surprising because an abundance of Spongia is generally not characteristic for deep-sea regions of the northern Pacific Ocean.

Even more massive were the Hyalospongia in two of the five trawling catches obtained from depths over 6 km by the Akademik Kurchatov expedition in the South Sakhalin trench [Vinogradova et al., 1974].

In the first of these takes from depth 7,200-7,216 m (st. 864, 56 species, 4,880 specimens), Spongia belonging to 4 species comprised about 7% both in number of specimens, and in the number of caught species, and their biomass percentage was 70%. In the second instance, in a catch from depth 6,766-6,875 m (st. 895, 27 species, 1,100 specimens), one species of Hyalospongia comprised 36% of the take of specimens and 98% in biomass (30 kg of 30.5). Such a significant dominance of Spongia at such depths is unique even for the Antarctic region, where it is well known that the Spongia are generally extremely characteristic for the benthic fauna. However, this refers mainly to the comparatively shallow depths of the shelf and the upper bathyal where Spongia often dominate in biomass above all other groups of animals [Beliaev, Uschakov, 1958; Pasternak, Gusev, 1960; Koltun, Pasternak, 1961; Koltun, 1964a]. At abyssal depths, even in the Antarctic waters, the Spongia usually lose their dominant role. Such a significant dominance of Spongia was not found as in the two aforementioned catches from the South Sandwich trench, nor in any of the 10 trawling catches obtained on the same trip in the abyssal depths in the neighboring regions of this trench [Vinogradova et al., 1974].

Representatives of the Calcispongia class have not been found in the deep-sea trenches. The greatest known depth of the dwelling of these Spongia until recently was less than 3,000 m [Burton, 1963; Koltun, 1964b] and only in 1966 was a lone representative of this class found near the Kuril Islands at depth 5,045 m [Koltun, 1970].

COELENTERATA

Representatives of almost all the major Coelenterata groups inhabit depths below 6,000 m (Appendix II, Table 4).

Hydrozoa. Hydroid polyps have been found in several Pacific Ocean trenches, in the Yavan trench and the Cayman trench. The deepest of the species defined as Hydroids is known from the Kermadec trench, from depth 8,210-8,300 m at which the Galathea expedition found a new species described by P. Kramp [1956] as Halisiphonia galatheae. Then, undefined close Hydroids were found by Vityaz at even greater depths, in the Kuril-Kamchatka trench at depths up to 8,185-8,400 m (st. 5612) and in the Tonga trench at depth 8,950-9,020 m (st. 6327). Based on the Hydroid data from the trenches only collections have been processed from Galathea in which Kramp defined 3 species. In the Kermadec trench, in addition to the aforementioned species, at a depth somewhat over 6.5 km yet another species was discovered that Kramp defined as the already known species Aglaophenia tenuissima that was previously found in the Great Australian Bight at depths 293 and 585 m. Kramp, however, notes some, although insignificant, differences between the Indian Ocean and Kermadec colonies. The third species found in the Yavan trench at depth about 7 km was a new one that apparently belonged to the same genus of Aglaophenia. According to the preliminary analysis [Keller et al., 1975], a representative of the same genus was also found in the Cayman trench.

It is important that at depths between 6 and 7 km in various regions of the Pacific Ocean, very large, single hydroid polyps from the genus Branchiocerianthus were found several times. For the first time 1 specimen of this hydroid was defined by D. V. Naumov in a sample obtained by Vityaz from the northwest trough from depth 6,096 m. Then in catches from depths over 6,000 m hydroids of this genus were not found, but they were detected on three photographs of the floor obtained in the New Hebrides trench, and on one in the Peru (see: [Lemche et al., 1976]). Lemche et al., assume that these giant hydroids (the size of the those photographed in the New Hebrides trench exceeds 25 cm) are classified predominantly with the abyssal Indian-Pacific Ocean type B. imperator, insofar as all the other known species of this genus are considerably smaller and are unknown in abyssal depths.

It should be noted on the whole that hydroid polyps at depths over 6,000 m are extremely scarce both in the species and in a quantitative respect, and are not characteristic for these depths.

Vityaz during its work in the Kuril-Kamchatka trench for the first time in a catch by a closing plankton net in the level from 8,700 to 6,800 m for the first time at these depths caught a small Hydromedusae described by D. V. Naumov [1971] as belonging to a new genus and species, Voragonema profundicola (Fig. 25). These findings are still singular, but different Hydromedusae (Anthomedusae, Leptomeusae and Trachymedusae) were found in the Palau, New Britain and New Hebrides trenches on 17 photographs at depths from 6,758 to 8,260 m [Lemche et al., 1976]. Trachymedusae (Fig. 25, B), probably belonging to the Crossota genus were noted in the Palau trench at depth about 8 km on 12 photographs, and by the calculations made by Lemche et al., their mean population density here was about 1 specimen per 100 m^2.

Scyphopolyps belonging to the genus Stephanoscyphus, including to the species S. simplex, from the Scyphozoa class were found in many trenches (all the way to depth 10 km). However, even judging by their external appearance (dimensions, color, theca shape), there are different species among them. Naumov [1961] believes that Stephanocsyphus is undoubtedly a combined genus that includes species of different families. S. simplex is apparently also a combined species. Numerous findings of scyphopolyps below 6 km indicate that Scyphomedusae must also live at these depths, although they have not yet been caught, apparently because their settlements are sparse and there are few plankton collections made deeper than 6 km. However, the existence of Scyphomedusae in the ultra-abyssal has now been proven. Scyphomedusae, apparently from the Ulmaridae have apparently been found on several photographs obtained in the Bougainville trench at depths 7,847-8,662 m [Lemche et al., 1976].

From the Anthozoa class, the only representatives of the Alcyonaria, Gorgonaria and Pennatularia corals have been found on photographs from several trenches in the western Pacific Ocean [Lemche et al., 1976], while the Pennatula of several species of the genus Khophbelemnon and Umbellula were caught at 15 stations in several trenches at depths slightly above 6,000 m. The most common sea fans were found in the Peru and South Sandwich trenches where they were caught several times, including in one trawling sample from the Peru trench (Akademik Kurchatov, st. 296) where there were 26 specimens and 1 specimen even in the bottom grab sample taken at this same station from depth 6,040 m. In the most extensively studied Pacific Ocean northern trenches, sea fans were only found at three stations and were not found once in this region on the bottom of the deep troughs, possibly because they mainly populate the slopes.

Of the Hexacorallia, representatives of the orders Antipatharia and Madreporaria are known below depth 6 km only from single findings. More characteristic, and sometimes mass, representatives of the Coelenterata in the ultra-abyssal depths are various Actinaria (Fig. 26), and primarily, the extremely unique Actinia of the family Galatheanthemidae Carlgren, 1956, whose body most often

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Figure 25. Trachymedusa

A. Voragonema profundicola from the Kuril-Kamchatka trench [per: Naumov, 1971]; B. ?Crossota sp. from bottom of Palau trench at depth 8 km [per: Lemche et al., 1976].

is located inside of a long coriaceous covering which looks like a black or dark brown cone. The dissemination of these Actinaria was extremely enigmatic for a long time. The first two species of Actinaria of this family were described by O. Carlgren [1956] from Galathea collections in the Philippine trench from depths from 9,820 to 10,210 m (Galatheanthemum hadale) and the Kermadec trench from depths from 5,850 to 8,300 m (G. profundale). The Galatheanthemums were then found repeatedly in various trenches. Until recently, they had only been known in 45 findings below 6,000 m from 16 Pacific and Atlantic Ocean trenches to maximum depths of the Mariana and Philippine trenches (five findings below 10 km). These Actinaria were also found on photographs taken in the Bougainville and New Hebrides trenches [Lemche et al., 1976], as well as the Puerto Rico trench [Heezen, Hollister, 1971] (Fig.

26, C). At the same time, Actinaria from this family from depths less than 6 km have only been known by three findings: one on the slope of the Kermadec trench at depth 5,850-5,900 m and two in the Scotia Sea in the South Sandwich and South Orkney trenches at depths between 5,465 and 6,000 m. There were thus all the grounds to consider the Actinaria of the family Galatheanthemidae, that are widespread in many separated trenches, to be essentially endemic for depths over 6,000 m.

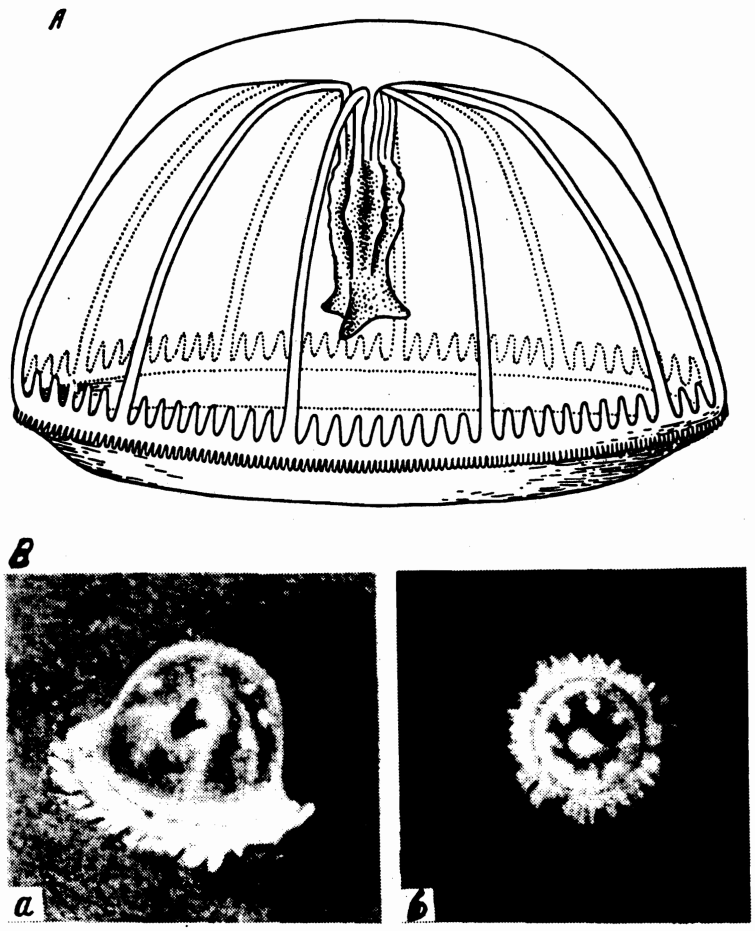

Рис. 25. Трахимедузы

А – Voragonema profundicola из Курило-Камчатского желоба [по: Наумов, 1971]; *Б* – ? Crossota sp. у дна желоба Палау на глубине 8 км [по: Lemche et al., 1976]

находится внутри длинного кожистого чехлика, имеющего вид конуса черного или темно-коричневого цвета. Распространение этих актиний долгое время представлялось чрезвычайно загадочным. Первые два вида актиний этого семейства были описаны О. Карлгреном [Carlgren, 1956] по сборам "Галатеи" из Филиппинского желоба с глубин от 9820 до 10 210 м (Galatheanthemum hadale) и из желоба Кермадек с глубин от 5850 до 8300 м (G. profundale). В дальнейшем галатеантемиды неоднократно встречались в различных желобах. До недавнего времени они были известны по 45 нахождениям глубже 6000 м из 16 желобов Тихого и Атлантического океанов вплоть до максимальных глубин Марианского и Филиппинского желобов (пять находок глубже 10 км). Были эти актинии обнаружены и на фотографиях, полученных в Бугенвильском и Ново-Гебридском желобах [Lemche et al., 1976], а также в желобе Пуэрто-Рико [Heezen, Hollister, 1971] (рис. 26, В). В то же время с глубин менее 6 км актинии этого семейства были известны лишь по трем нахождениям: одно – на склоне желоба Кермадек на глубине 5850–5900 м и два – в море Скотия в районе Южно-Сандвичева и Южно-Оркнейского желобов на глубинах между 5465 и 6000 м. Таким образом, были все основания считать актиний семейства Galatheanthemidae, широко распространенных во многих разобщенных желобах, практически эндемичными для глубин более 6000 м. Такое

Figure 26. Various Actinaria Photographed on the Trench Floor

Key:
a. New Hebrides, about 6,770 m, height without feelers 8 cm
b. New Britain, 7 km
c. Galatheanthemum, Bougainville trench, about 8 km [per: Lemche et al., 1976]

It was difficult to explain this dissemination, and it remained enigmatic until the 1983 publication of data on numerous findings of Galatheanthemidae during the seven expeditions of the ship Eltanin in the Antarctic waters [Dunn, 1983]. As indicated by these expeditions, the Galatheanthemidae, classified as the same species as those described form the Kermadec trench (G. profundale), are essentially widespread throughout the Antarctic at depths from 4 to 5 km (over 200 specimens have been found at 16 stations during trawlings at depths from 3,947-4,063 to 5,087-5,124 m). The currently known dissemination of Galatheanthemidae is shown in Fig. 27. The new data allow us to hypothesize that the family formation center was confined to the Antarctic water abyssal, from which these Actinaria resettled into many deep-sea trenches. It is still not understood why the Galatheanthemidae in all the regions, except for the Antarctic, are confined only to depths over 6 km. Unfortunately, all the data on the Galatheanthemidae, except for the Galathea and Eltanin collections, have not yet been processed, and it is not known if they are endemic species in various separated trenches.

There is about a 70% rate of incidence of various Actinaria at depths over 6,000 m (the stations for which group animal data composition are known in trawling catches were taken into account), and their population role at depths over 10 km exceeds 20% of all benthic invertebrates that are represented in the trawling catches obtained from these depths (see Fig. 55).

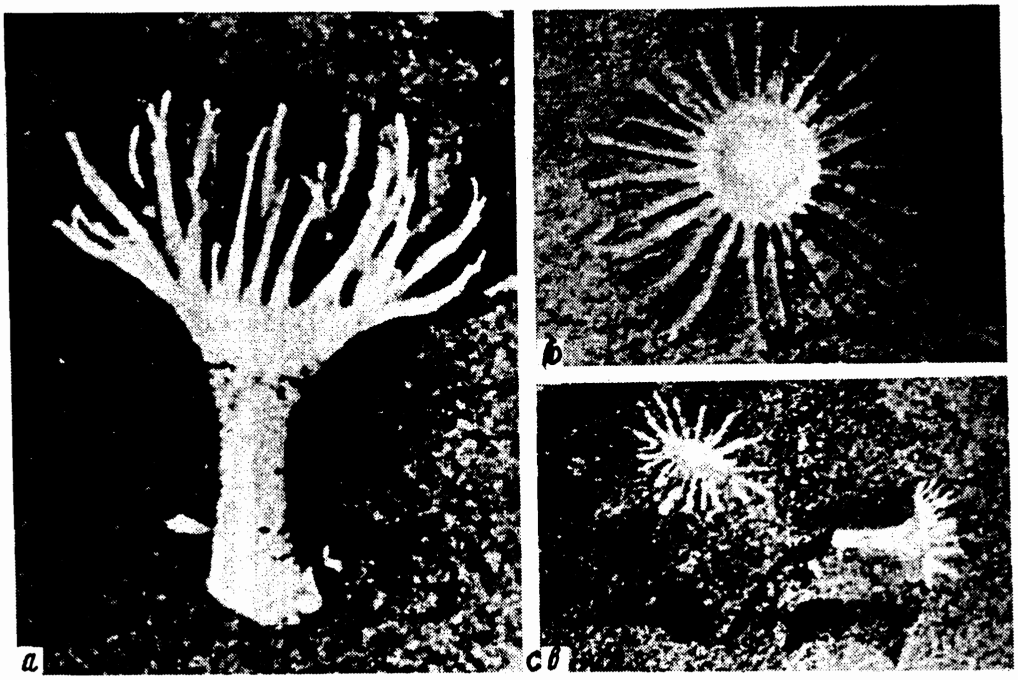

Рис. 26. Разные актинии, сфотографированные на дне желобов

а – Ново-Гебридский, около 6770 м, высота без щупалец 8 см; *б* – Ново-Британский, 7 км; *в* – Галатеантемиды, Бугенвильский желоб, около 8 км [по: Lemche et al., 1976]

распространение было трудно объяснить, и оно оставалось загадкой вплоть до публикации в 1983 г. данных о многочисленных нахождениях галатеантемид во время семи экспедиций судна "Илтенин" в антарктических водах [Dunn, 1983]. Как показали эти экспедиции, галатеантемиды, относящиеся к тому же виду, что и описанные из желоба Кермадек (G. profundale), распространены практически циркумантарктически на глубинах от 4 до 5 км (более 200 экз. найдены на 16 станциях при тралениях на глубинах от 3947–4063 до 5087–5124 м). Известное теперь распространение галатеантемид показано на рис. 27. Новые данные позволяют предполагать, что центр формирования семейства был приурочен к абиссали антарктических вод, откуда и произошло расселение этих актиний и заселение ими многих глубоководных желобов. Остается все же непонятным, почему галатеантемиды во всех районах, кроме Антарктики, приурочены только к глубинами более 6 км. К сожалению, все материалы по галатеантемидам, кроме сборов "Галатеи" и "Илтенина", остаются до сих пор не обработанными и не известно, представлены ли они в разных разобщенных желобах эндемичными видами.

Частота встречаемости различных актиний на глубинах более 6000 м (учтены станции, для которых известны данные по групповому составу животных в траловых уловах) составляет около 70%, а их роль по численности на глубинах более 10 км превышает 20% всех донных беспозвоночных, представленных в полученных с этих глубин траловых уловах (см. рис. 55).

Figure 27. Dissemination of Actinaria of the Family Galatheanthemidae

Key:
1. at depths 4,000-6,000 m; 2. from 6,000 to 10,700 m; 3. findings in Scotia Sea at depth 5,650-6,070 m; 4-6. regions of repeated findings below 6,000 m in trenches: 4--Kuril-Kamchatka and Japan (12 stations), 5. Philippine (6 stations), 6. Kermadec (5 stations)

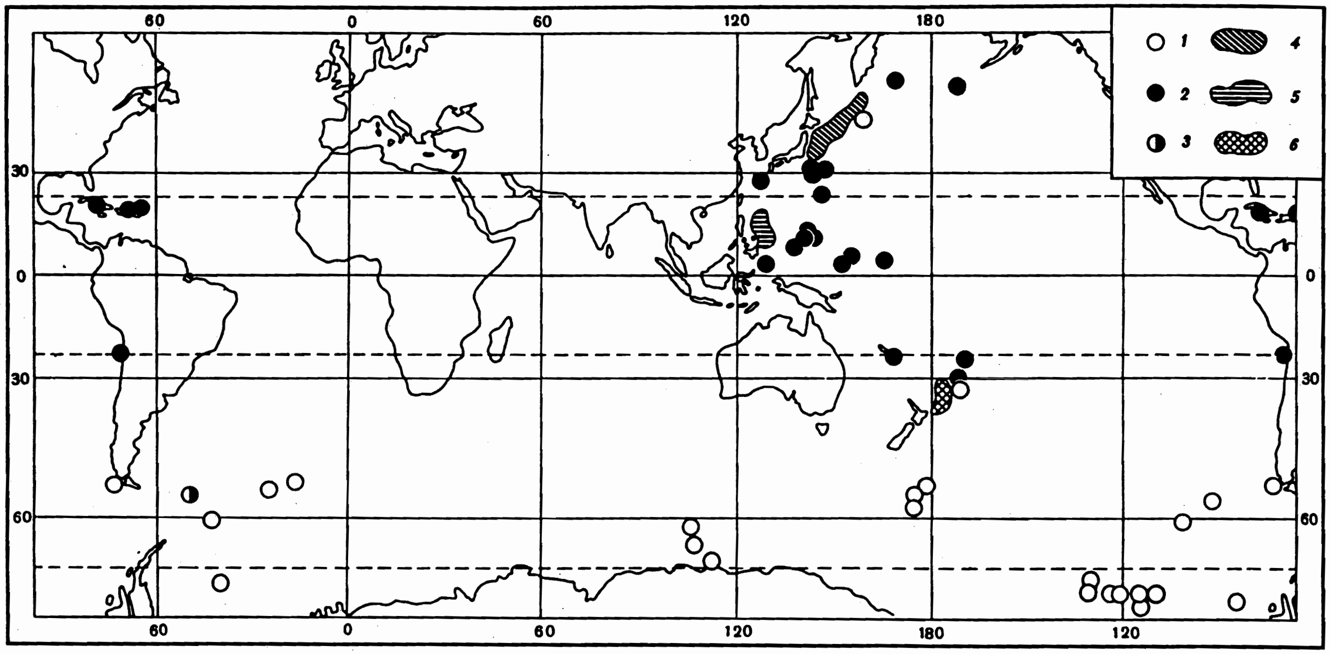

Рис. 27. Распространение актиний семейства Galatheanthemidae

1 – на глубинах 4000–6000 м; *2* – от 6000 до 10700 м; *3* – нахождение в море Скотия на глубине 5650–6070 м; *4–6* – районы неоднократных нахождений глубже 6000 м в желобах: *4* – Курило-Камчатском и Японском (12 станций), *5* – Филиппинском (6 станций), *6* – Кермадек (5 станций)

PLATHELMINTHES

TURBELLARIA

Turbellaria from the order Polyclada were found twice in the Kuril-Kamchatka trench during a detailed examination in 1966. One specimen was taken during trawling at depth 7,265-7,295 m, and the second was found in a catch at depth 9,170-9,335 m, but it is not excluded that this was a pelagic form that fell into the trawl net at a shallower depth. Additionally, Turbellaria were found in several catches from the research vessel Anton Bruun in the Peru trench from depths 6,000-6,354 m with a small-mesh (500 μm mesh) trawl net by Menzies [Menzies, Chin, 1966]. Based on these data, in order to find Turbellaria it is necessary to use special collection methods, since catches by standard trawl lines apparently destroy these animals with an extremely fragile structure. This is confirmed by the data from the only sample taken by the box corer 0.25 m^2 in the Aleutian trench from depth 7,298 m [Jumars, Hessler, 1976]. In this sample made of 518 specimens of meiobenthos animals, there where 37 specimens of Turbellaria, which converts to 148 specimens/m^2.

NEMATHELMINTHES

GASTROTRICHA

Based on preliminary data, Gastrotricha are apparently represented in collections from depths 6,000-6,354 m taken in the Peru trench by a small-mesh trawl net [Menzies, Chin, 1966].

NEMATODA

Until the mid-1950's, free-living Nematoda were not known from depths over 4,570 m [Wieser, 1956]. But during an examination of deep-sea trenches they were encountered at all depths, even up to depth 10,415-10,687 in the Tonga trench [Beliaev et al., 1960]. Below 6,000 m they were found at more than 60 stations in 18 trenches of all three oceans [Wolff, 1960; Menzies, Chin, 1966; Menzies et al., 1959; Pasternak, 1968; Vinogradova, 1974; Vinogradova et al., 1974, 1978; Beliaev, Mirnov, 1977a].

During special collections of microbenthos by the Meteor expedition in the Indian Ocean, the larger Nematoda averaged 84% of the specimens at the abyssal depths. Their population at these depths fluctuated from 57 to 199 specimens per 25 cm^2 of the bottom surface [Thiel, 1966], which in conversion for 1 m^2 yields enormous levels on the order of 20,000-80,000 specimens/m^2. The use of the same collection methods to process six bottom grab samples obtained by Meteor in the Iberian trough of the Atlantic Ocean at depths from 5,270 to 5,340 m yielded even more amazing results. Nematoda here comprised 95% of the entire meiobenthos, and their population fluctuated from 390 to 696 specimens per 25 cm^2 [Thiel, 1972], which in conversion yields from 156,000 to 278,000 specimens/m^2. These data permitted the hypothesis that even below 6 km there could be numerous Nematoda and they could comprise one of the characteristic fauna features of the meio- and microbenthos. This was confirmed by the data from the aforementioned box corer sample in the Aleutian trench from depth 7,298 m [Jumars, Hessler, 1976]. There were 194 Nematoda specimens in this sample (776 specimens/m^2, or 36% of the total number of meiobenthic animals).

Only collections from the research vessel Anton Bruun from the Peru trench have already been taxonomically classified and four new species have been described [Timm, 1970] of the order Desmoscolecida: Desmoscolex bathybius, st. 98, 5,989-6,052 m; D. gladisetosus, st. 113, 5,986-6,134 m; D. volifer, st. 191, 6,313 m; Quadricoma desmoscoleocoides, st. 193, 6,073-6,281 m. Of these species, only the first was not found at shallower depths. The other three had been found in the area of this trench and at depths between 3,086 and 5,047 m [Timm, 1970].

CEPHALORYNCHA

PRIAPULOIDEA

Only one species of Priapuloidea, Priapulus tuberculatospinosus abyssorum, is known from depths over 6 km. This Priapulus was initially [Menzies, 1959] described as an independent species of P. abyssorum based on a single specimen from the eastern Pacific Ocean near the coast of Central America from depth 5,690 m. Subsequently [Murina, Starobogatov, 1961] the status of this species was reduced to a subspecies level within the species P. tuberculatospinosu Baird, P. t. abyssorum Menzies. In contrast to the other two subspecies in this species that are known only from low depths (P. t. tuberculatospinosus, a circum-Antarctic subspecies widespread at depths up to 625 m, and P. t. japonicus Mur.et Starob., the only finding in the Sea of Japan at depth 130 m), P. t. abyssorum is widespread at depths over 3,000 m in the Pacific Ocean, and is also known from the eastern Indian Ocean. This subspecies has now been found in Vityaz collections from the Aleutian trench (st. 6,085 and 6,140--6,960-7,000 m), Kuril-Kamchatka (st. 2208 and 5616--7210-8015 m), Japan (st. 3227, 3571 and 6151--7190-7587 m), Yavan (st. 5168--6433-6475 m), as well as in collections of the research vessel Anton Bruun from the Peru trench from depth 6,229 m and research vessel Dmitriy Mendeleyev from the Hjort trench (st. 1306--6,100-6,210 m) [Murina, Starobogatov, 1961; Beliaev, 1966b, 1972; Frankenburg, Menzies, 1968; Murina, 1969, 1971, 1978b].

The overall vertical habitat range of P. t. abyssorum is from 3,013 to 8,015 m. In almost all cases of finding this subspecies there were only single specimens.

NEMERTINI

Individual Nemertini (usually only fragments) have been found below 6,000 m at seven stations in the Kuril-Kamchatka, Aleutian and Peru trenches, and in the northeast Pacific Ocean trough, the South Sandwich trench, and the Scotia Sea in the Atlantic at depths to 7,230 m by Vityaz and Akademik Kurchatov expeditions [Beliaev, 1966b, 1972; Vinogradova et al., 1974].

ANNELIDES

POLYCHAETA

In the deep-sea trenches, as in the ocean abyssals, Polychaeta are one of the most customary and abundant groups of benthic invertebrates that are characterized by great species diversity. Polychaeta occupy first place in frequency of encounter among all benthic invertebrates, about 90% both in the trawling and bottom grab samples. They are inferior in population and biomass on the average for the entire ultra-abyssal zone only to the Holothurioidea and Bivalvia. They also occupy one of the first places in the trench benthic fauna in the number of species.

Polychaeta have been found below 6,000 m in all the studied trenches and troughs, except for the Zeleniy Mys trough from which only one not very representative sample was obtained. The greatest depths of finding Polychaeta are from 10,160 to 10.730 m in the Philippine, Mariana and Tonga trenches (several species of the family Polynoidae and Poecilochaetus vitjazi from the Disomidae family).

Polychaeta have been processed by now from most of the collections from the Soviet expeditions on the vessels Vityaz, Akademik Kurchatov and Dmitriy Mendeleyev [Uschakov, 1952-1982; Levenstein, 1961-1983; Levenstein, 1971, 1977, 1984; Kucheruk, 1977-1981; Detinova, 1982; Safronova, 1984], data of the Galathea expedition [Kirkegaard, 1956] and some of the collections of other foreign expeditions [Eliason, 1951;

Hartman, 1967a, b; Jumars, 1974; Fauchald, 1977; Shin, 1984]. Pettibone [1976] also reviewed deep-sea representatives of the Polynoidae family (formerly the Macellicephalinae s. lato sub-family) with re-study of the materials collected by a number of expeditions in deep-sea trenches. As a result of this review, Pettibone isolated several new subfamilies and genera, including subfamilies Macellicephaloidinae and Bathyedithinae endemic for the ultra-abyssal and 4 endemic genera Bathykermadeca, Bathykurila, Bathyedithia, and Bathylevensteinia.

Numerous findings of Polychaeta have also been noted in five trenches of the western Pacific Ocean in which a large number of underwater photographs were taken from depths from 6,758 to 8,930 m [Lemche et al., 1976].

The composition of Polychaeta dwelling at depth over 6,000 m is extremely variegated (Appendix II, Table 5). At these depths, representatives have been found of 7 orders, 26 families and 50 genera. Of the 75 species (one with two subspecies) for which there are species analyses[1], 30 species (40%) are endemic to depths over 6,000 m (of them, 14 species are known by a single finding and 16 by several findings). Additionally, many species have been defined only to the genus or to the family (not precisely defined because of the fragmented nature or poor preservation of the material; preliminary analyses requiring refinement; forms known only from underwater photographs), 26 such analyses are known for 85 samples from various trenches and different depths.

The endemic genera are 7 out of 50, i.e., endemism at the generic level is 14%. Insofar as the species affiliation has only been defined for some of the collected Polychaeta, while collections from some expeditions have not been processed at all, one can hypothesize that the total number of Polychaeta species dwelling below 6,000 m should be no less than 150-200.

Of all the Polychaeta for the trench depths, the most characteristic representatives are the Polynoidae family belonging to the group that was previously combined into the Macellicephalinae subfamily. Of the number of Polychaeta for which there are species analyses, this family includes 20 species (28%), of them 17 (85%) are endemic for depths over 6,000 m; these 20 species belong to 9 genera, of which 6 are endemic to the ultra-abyssal. Of all the other ultra-abyssal Polychaeta, over 5 species do not belong to any of the families, and of the 40 genera, only 1 (Vityazia from the Phyllodocidae family) are endemic to the ultra-abyssal. Both endemic ultra-abyssal subfamilies belong to the Polynoidae family.

Based on the underwater photographic data, Lemche et al. [1976] calculated that the abundance of two Polynoidae representatives on the floor of the New Hebrides trench at depth 6,758-6,776 m averages 1 specimen each for 100 m^2 of bottom. Up to 4 specimens of Polynoidae were sometimes visible on one photograph. In 5 trenches where photographs were taken, Polynoidae were detected on many photographs at 6 of 7 stations (depths 6,758-8,930 m). It is important that in a number of cases the photographs showed Polynoidae not only on the bottom, but also floating near the floor. This capability to float was detected in Polychaeta of this family for the first time and was noted for at least three species [Lemche et al., 1976].

According to the nature of the vertical distribution (Fig. 28), among the species found below 6,000 m, the most eurybathic species known from the sublittoral to the ultra-abyssal play a major role based on the available data; these species comprise 26% of all the ultra-abyssal Polychaeta species. Abyssal-ultra-abyssal species that do not rise above 3,000 m comprise 21%. It is very curious that the species which are intermediate between the two known groups from the bathyal (500-3,000 m) to the ultra-abyssal comprise only 10% of all the species dwelling below 6,000 m, i.e., 2.5 times less than the number of species noted in a still broader range of depths. This species ratio with a varying degree of eurybathic nature forces us to hypothesize that many

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[1] In several cases the analyses are questioned by their authors; it is most likely that these doubted analyses refer to new species.

Figure 28. Vertical Dissemination of Polychaeta Known from Depths over 6 km (A) and Change with Depth (B) of the Number of Species (1) and Percentage of Endemic Species (2). Ordinate: depth, km.

species, that per the available analyses, are classified as sublittoral-ultra-abyssal species are defined erroneously. It is possible that the representatives of such species that were found in the deep-sea trenches penetrated into the ultra-abyssal comparatively recently and that their evolution under the new conditions has not yet proceeded so far as for fairly distinct morphological signs to appear so as to distinguish them from representatives of the shoal populations. In any case, from general biological positions it is extremely difficult to assume that populations separated 6 km and more in depth could be classified as the same species. Lengthy experience of working with hadal fauna under field conditions indicates that live and viable representatives of different animal groups can rise to the surface from a depth over 1,500-2,000 m. Apparently, in this case under discussion either we are not catching the morphological differences existing between representatives of populations from different depths, or we are dealing with so-called biological species where the differences between them are expressed on physiological and biochemical levels.

As is apparent from Fig. 28, as the depth increases within the ultra-abyssal zone, the number of Polychaeta species diminishes drastically, in a depth range from 6 to 7 km there are 51 known species, and over 10 km there are now only 3 known species. Additionally, of the 90 locations in which Polychaeta were found, 39 locations have been defined only to the genus or to the family (27 taxons of these ranks) belonging to the depth interval from 6 to 7 km, 22 from 7 to 8, 17 from 8 to 9, 8 from 9 to 10 and only 4 to depths over 10 km. In addition, the percentage of ultra-abyssal endemics rises as the depth increases: in the level 6-7 km there are only 22% endemics, while below 10 km there are 100%.

Pelagic Polychaeta have been found in the Kuril-Kamchatka trench all the way to depths over 7,000 m. In the 7,000-8,700 m range their biomass is 6.5% of the total biomass of mesoplankton [Vinogradov, 1968, 1970a].

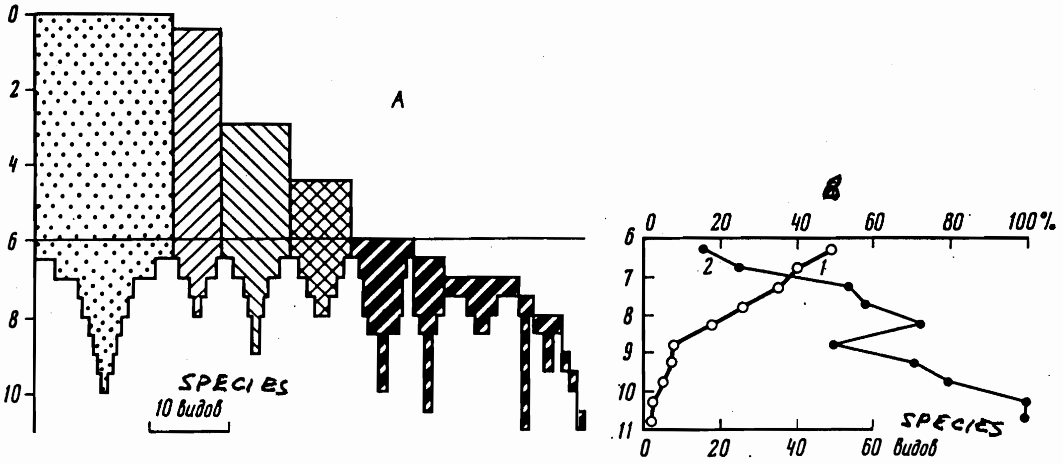

Рис. 28. Вертикальное распространение Polychaeta, известных с глубин более 6 км (*А*), и изменение с глубиной (*Б*) числа видов (*1*) и процента эндемиков (*2*). Ордината – глубина, км

гие из видов, относящихся, согласно имеющимся определениям, к сублиторально-ультраабиссальным видам, определены ошибочно. Возможно, что найденные в глубоководных желобах представители таких видов проникли в ультраабиссаль сравнительно недавно и их эволюция в новых условиях еще не зашла настолько далеко, чтобы появились достаточно четкие морфологические признаки, отличающие их от представителей мелководных популяций. Во всяком случае, с общебиологических позиций чрезвычайно трудно допустить, чтобы популяции, разделенные 6 км и более по глубине, могли относиться к одному и тому же виду. Длительный опыт работы с глубоководной фауной в полевых условиях показывает, что живых и жизнеспособных представителей разных групп животных удается поднимать на поверхность с глубины не более 1500–2000 м. По-видимому, мы в обсуждаемом случае либо не улавливаем существующих между представителями популяций с разных глубин морфологических различий, либо имеем дело с так называемыми биологическими видами, различия между которыми пока выражены на физиологическом и биохимическом уровнях.

Как видно из рис. 28, по мере увеличения глубины в пределах ультраабиссальной зоны число видов полихет резко уменьшается – из диапазона глубин от 6 до 7 км известен 51 вид, а с глубин более 10 км пока извесны лишь 3 вида. Кроме того, из 90 местонахождений, в которых найдены полихеты, определенные только до рода или до семейства (27 таксонов этих рангов), 39 местонахождений относится к интервалу глубин от 6 до 7 км, 22 – от 7 до 8, 17 – от 8 до 9, 8 – от 9 до 10 и лишь 4 – к глубинам более 10 км. Наряду с этим процент эндемиков ультраабиссали по мере увеличения глубины возрастает: в горизонте 6–7 км эндемики составляют лишь 22%, а глубже 10 км – 100%.

Пелагические полихеты встречены в Курило-Камчатском желобе вплоть до глубин более 7000 м. В горизонте 7000–8700 м их биомасса составляла 6,5% от общей биомассы мезопланктона [Виноградов, 1968, 1970а].

ОЛИГОХЕТЫ – OLIGOCHAETA

Представители класса олигохет, перешедшие вторично к жизни в море, до недавнего времени не были известны с больших глубин. Но в конце 60-х годов представители семейства Tubificidae впервые были найдены в северо-западной части Антантического океана на глубинах до 4850 м [Cook, 1969, 1970]. В дальнейшем олигохеты этого же семейства были найдены и в других районах Мирового океана, в том числе к северу от

OLIGOCHAETA

Representatives of the Oligochaeta class that made a secondary transition to life in the sea were not known at great depths until recently. But at the end of the 1960's representatives of the Tubificidae family were found for the first time in the northwestern part of the Atlantic Ocean at depths up to 4,850 m [Cook, 1969, 1970]. Oligochaeta of the same family were then found in other regions of the World Ocean, including to the north of the Hawaiian Islands where single specimens were found in five samples taken by box corer by the American research vessel Argo at depths from 5,600 to 5,700 m [Hessler, Jumars, 1974]. Then the deepest sea of the currently known Oligochaeta species was described, Bathydrillus hadalis Erseus, 4 specimens from a bottom grab sample obtained by the research vessel Thomas Washington in the Aleutian trench from a depth of 7,298 m [Erseus, 1979].

ECHIURA

Echiura representatives have been found below 6,000 m in 17 trenches at all depths all the way to 10,150-10,210 m in the Philippine trench. They are known at these depths from over 60 findings (Appendix II, Table 6). The frequency of finding Echiura in trawling catches from depths over 6,000 m is about 35%. Most of the collections of Vityaz, Akademik Kurchatov and Galathea have already been processed [Zenkevitch, 1958, 1964; Zenkevitch, 1966; Zenvitch, 1966; Zenkevitch, Murina, 1976; Murina, 1976, 1978a; Datta Gupta, 1977]. All the Echiura dwelling below 6 km belong to one family, Bonelliidae. Representatives of no less than 10 genera, and apparently, no less than 14 species have been found in the deep-sea trenches.

Several species that were initially considered to be endemic for the ultra-abyssal zone were subsequently found at shallower depths. There are now only 4 known endemic species of the 13 for which there are species definitions. Five of the species, except for depths over 6 km, are known also from the abyssal depths (below 3,800 m), three have been found at bathyal depths (520-2,900 m). Yet another species found in the Ryukyu and Palau trenches at depths 7,440-8,035 m have been classified [Murina, 1978a] as the widespread Arctic-Antarctic sublittoral-bathyal species Hamingia artcitca that is known starting from depth 65 m. It is likely that in this case Echiura from the deep-sea trenches belong to a special biological species whose morphological differences from the shoal species have not yet been detected. None of the Echiura genera penetrating from deeper than 6,000 m are endemic for these depths.

Despite the comparatively low percentage of endemic species, the Echiura comprise a very characteristic element of the ultra-abyssal fauna, including the fauna of the greatest depths (no less than five species penetrate below 9 km). It is characteristic that in this group which is small in the number of species (based on the data of A. Kaestner, by the end of the 1960's there was a total of 150 known species of Echiura [Kaestner, 1969]) almost 10% of the species had populated depths over 6,000 m.

Interesting Echiura that belong to a new genus and species described by Datta Gupta [1977] , Kurchatovus tridentatus, were found by the expedition on the Akademik Kurchatov. They were found in the Puerto Rico trench in a wood fragment raised from depth 5,890-6,000 m (st. 1187), in the Cayman trench at depth 6,740-6,780 m among the Thalassia sea grass rhizome (st. 1267) and in the Yucatan trough in a coconut shell raised from depth 4,580 m (st. 1272). T. Wolff [1976b, 1979], a participant of this expedition, judging by the contents of the intestines of these worms, indicated that they feed on the vegetation among which they live.

ARTHROPODA

TARDIGRADA

For a long time only very few Tardigrada were known from the seas, where they were only found at shallow depths (up to 385 m). But in special microbenthos collections made by the Meteor expedition in the western Indian Ocean, Tardigrada, although only a few, were found in the abyssal in several samples from depths up to 4,690 m [Thiel, 1966]. In 1969, the only miniature Tardigrada specimen (which unfortunately was subsequently lost) was found in a bottom grab sample obtained by Vityaz in the Aleutian trench from depth 6,520 m. A more accurate taxonomic affiliation of this Tardigrada has not been established. It is known that representatives of this group are distinguished by extreme eurybiontic nature and the ability to survive in a condition of anabiosis under the most unfavorable conditions. It can therefore be hypothesized that the Tardigrada could also adapt to dwelling at ultra-abyssal depths where they may be found in the future.

CRUSTACEA

Of the shallower Crustacea below 6,000 m representatives have been found of the order Copepoda, Cirripedia and Ostracoda. Of the higher, representatives have been found of Mysidacea, Cumacea, Tanaidacea, Isopoda, Amphipoda and Decapoda Natantia.

COPEPODA

At depths over 6,000 m both pelagic Copepoda, Calanoida (Appendix II, Table 7) and benthic, Harpacticoida are represented.

Data on the ultra-abyssal Calanoida are known from the Vityaz Kuril-Kamchatka trench collections. K. A. Brodskiy [1955] in a sample first obtained in 1953 by a closing plankton net during a catch from level 8,500 to 6,000 m defined 20 taxons of the species rank belonging to 17 genera and 10 families. Two genera, Zenkevitchiella and Parascaphocalanus, were new. But subsequently another two species of the first of these genera were described from the Atlantic and Indian Oceans from shallower depths [Grice, Hulsemann, 1965, 1967]. Of the 20 species and forms, 10 were described by Brodskiy as new, and regarding another five that had insufficient data, they could not be classified to any of the known species. Further, of the 10 new species, 3 were also encountered at low depths: Batheuchaeta gurjanovae and Lucicutia ushakovi in the area of the same trench [Gentner, 1971, 1973, 1986; Markhaseva, 1986a], and Scaphocalanus bogorovi in the Atlantic and Indian Oceans [Grice, Hulsemann, 1965, 1967]. However, the 12 species (or forms) found by Brodskiy in the discussed sample have not yet been found in other places, and it is not excluded that they are endemic for the ultra-abyssal depths of the Kuril-Kamchatka trench. It is quite characteristic that precisely some of these species have been found in massive amounts in a sample: 64 specimens of Spinocalanus similis profundalis, 97 specimens of Parascaphocalanus zenkevitchi, and 37 specimens of Metridia similis abyssalis. There were only single specimens in the sample of the other species.

In collections of subsequent years from the Kuril-Kamchatka trench during catches covering depths over 6,000 m (but not limited only to these depths, see Table 7) another 11 new species were described [Gentner, 1971, 1986; Markhaseva, 1981, 1986a, b; Vyshkvartseva, 1987], but only for three of them can it be hypothesized that their vertical dissemination range does not cover depths less than 6,000 m[1].

Of the 32 species, or forms, found in the Kuril-Kamchatka trench, thus 15 (47%) are apparently not present at depths less than 6,000 m. Ten species are known from even lower depths, but do not rise above the abyssal 93-4 km) and have a local geographical dissemination only in the northwest Pacific Ocean (only one of these species, Lucicutia curvifurcata has also been encountered in the Bougainville trench). The other 6 forms defined to the species level belong to eurybathic and for the most part widespread species.

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[1] When this book was at press, a description was published [Vyshkvartseva, 1989] of a specimen of the family Scolecithricidae belonging to a new genus and species, Puchinata obtusa. The only adult specimen was found in a sample obtained by a closing plantkon net in the Kuril-Kamchatka trench at level 8,000-6,500 m (Vityaz, st. 5628). Vyshkvartseva classified as this same species the previously described specimen [Brodskiy, 1955], that had only been defined as the fourth Copepoda stage caught in the same trench at level 8,500-6,000 m (Vityaz, st. 2218), see Appendix II, Table 7. This Crustacean that is known from two findings may be considered as belonging to ultra-abyssal endemics on a generic level.

Deep-sea benthic representatives of Copepoda that belong to the suborder Harpacticoida are so small that in order to obtain fairly representative samples of these Crustaceans it was necessary to use special methods of collecting benthic sediment and then process them. Thus, for example, the use of a special meiobenthos collection technique allowed H. Thiel [1966] to find numerous Harpaticoida in the thin surface layer of soil brought up by the bottom grab in all the samples obtained at abyssal depths (3,000-5,000 m) in the Indian Ocean by the Meteor expedition. In conversion for unit of bottom area, their population fluctuated from 400 to 11,600 specimens/m^2. In the sample taken by the box corer in the Aleutian trench from depth 7,298 m there were 83 specimens of Harpaticoida (mainly in the surface three-centimeter soil layer) [Jumars, Hessler, 1976] which in conversion yields 332 specimens/m^2.

Of the Harpacticoida found below 6,000 m, a precise species affiliation has been established only for one (Vityaz, st. 3471, 6071 m) that belonged to a new genus and species from the family Cerviniidae, Herdmaniopsis abyssicola Brotzkaja as described by V. A. Brotzkaja in her posthumously published work [1963]. This same publication describes three new species of the genus Cervinia (C. brevipes, C. tenuicauda and C. tenuiseta) that were found in one sample obtained from depth about 5,700 m somewhat to the east of the northern Izu-Bonin trench. Judging by the depth of their location, it is quite likely that these species dwell even below 6 km. Based on one specimen, another two species were found in the Yavan and Mariana trenches [Beliaev, Vinogradova, 1961a; Beliaev, Mironov, 1977a]. In the Yavan trench (Vityaz, st. 4535, 6841 m) Crustacea were caught that per the analysis of V. A. Brotzkaja, belong to a new genus and species from the family Gletodidae, and in the Mariana trench (Vityaz, st. 7360, 6,580-6,650 m) a new species of the genus Bradya from the family Ectinosomatidae (analysis of L. L. Chislenko).

In addition to the already mentioned, there were Harpacticoida that were not precisely defined (for the most part single specimens) and were caught below 6 km in the Aleutian, Tonga, Kermadec, Peru, Yavan and Romanche trenches [Beliaev et al., 1960; Menzies, Chin, 1966; Pasternak, 1968; Jumars, Hessler, 1976]. The deepest sea findings were in the Kermadec trenches at depths about 9 and 10 km (Vityaz, st. 3827 and 3831).

Cirripedia

Cirripedia are not characteristic for the ultra-abyssal depths, and with a single exception, are not specific for these depths. They have been found in 16 trawl samples from depths 6 to 7 km in the Kuril-Kamchatka, Japan, Izu-Bonin, Ryukyu, Kermadec, Peru trenches and in the northwest trough of the Pacific Ocean, and only once was a juvenile specimen of the Acroscalpellinae family found in a sample from the Philippine trench from depth 7,420-7,880 m. In the majority of cases, the Cirripedia were only represented in samples as one or two specimens. All of the known Cirripedia from depths over 6 km belong to the family Scalpellidae, of them 7 were defined to the species and another 3 to the genus or subfamily. Only one of the 7 species, Meroscalpellum ultraabyssalis, has been known by a single finding in the Ryukyu trench at depth 6,660-6,670 m. Two species that were only found slightly deeper than 6 km also dwell in the lower abyssal and have a narrow geographical dissemination. The other 4 species are characterized by broad geographical dissemination and dwell in the range of depths from the bathyal to over 6 km. The list of species is given in Appendix II, Table 8.

Ostracoda

There are apparently very few Ostracoda in the deep-sea trenches, but they have not yet been studied sufficiently. Both benthic and pelagic forms are known from depths over 6,000 m (Appendix II, Table 9). From the benthic Ostracoda 7 species are known from Soviet expedition collections in five trenches of the Pacific, Indian and Atlantic Oceans, but three of them have only been defined to the genus, and another new species has not been described. One eurybathic species has also been described from the Peru trench based on the research vessl Anton Bruun expedition collections and three undefined specimens were found close by in the Aleutian trench (Thomas Washington, st. N-39). Of the five forms defined to species, 3 species and 1 genus had not been found higher than depth 6 km, and 2 are classified as eurybathic widespread species. The greatest depth from which benthic Ostracoda are known is 7,950-8,100 m in the Puerto-Rico trench. The list of the already described deep-sea Ostracoda is given in the work of G. Hartmann [1985].

Pelagic Ostracoda found below 6,000 m are only known from Vityaz collections and belong to six species; of them, 2 species from the Kuril-Kamchatka trench are not been found at lower depths; 3 species are also known from the abyssal depths and are encountered in several trenches of the western part of the Pacific Ocean, and yet another widespread species is known, starting from depths 500-700 m.

Mysidacea

There are still few data about deep-sea benthic (more precisely, bottom-dwelling) Mysidacea. In the list of benthic Mysidacea found in the Pacific Ocean at depths over 2,000 m published in 1969 only 5 species were indicated [Burshteyn, 1969b], including only one (Amyblyops magna) from the ultra-abyssal Kuril-Kamchatka trench. In 1971 Bacesco [1971] from the Peru trench described a second species from a depth slightly over 6,000 m, Mysimenzies hadalis. According to preliminary analyses of Yu. G. Chindonova [1981 and unpublished data] benthic Mysidacea from depths over 6 km have been known by now from 8 trenches of the Pacific Ocean (Aleutian, Japan, Volcano, Ryukyu, Yap, Palau and Banda, and from the Antarctic Hjort trench), as well as from the South Sandwich trench. Yet another, apparently new species was also found in the Kuril-Kamchatka trench (see Appendix II, Table 10). Ten new species were found in these trenches. Their descriptions have not yet been published, however. The greatest depth of finding Mysidacea is 8,560-8,720 m in the Yap trench. Of the 12 known species from depths over 6,000 m, only 3 species have also been found in the lower abyssal subzone (below 4,500 m), and the other 9 (75%) are endemic for depths over 6,000 m.

All the ultra-abyssal Mysidacea belong to 5 genera of the Mysidae family (Amblyops, Birsteiniamysis, Mysimenzies, Michthyops and Paramblyops), and none of these genera are endemic for the ultra-abyssal depths.

Crustacea apparently belonging to the order Mysidacea were also found near the bottom on more than 40 underwater photographs taken at four stations in the Palau, New Britain, Bougainville and New Hebrides trenches at depths from 6,758 to 8,662 m [Lemche et al., 1976].

As indicated by M. Ye. Vinogradov [1968, 1970a], the catch by closing plankton net from depth 7,000-6,000 m in the Kuril-Kamchatka trench caught the pelagic Mysidacea Boreomysis incisa Nouvel that is also known at abyssal depths. Mysidacea of this same species were successfully caught several times during open catches by a plankton net from depths over 6,000 m to the surface in the Japan, Izu-Bonin and Ryukyu trenches. Additionally, based on a single specimen caught during a catch from 6,600 m to the surface in the Ryukyu trench, the species Dactylamlyops tenella Birst. et Tchind. was described [Birstein, Tchindonova, 1958].

J. M. Peres reports that when the bathyscaphe Archimede submerged in the Puerto Rico trench, he observed Euphausiacea at depths between 6,100 and 6,450 m and 1 specimen below 6,600 m [Peres, 1965]. However, as indicated by Peres himself, as well as by a participant in one of the descents of this bathyscaphe, T. Wolff [1971], the rate of submersion (20-30 cm/sec or more) made it very difficult to make an accurate determination of the plankton animals floating past the porthole. As far as it is known, the greatest depth of catching Euphausiacea by closing plankton nets during repeated operations in the Kuril-Kamchatka trench was 6,000-5,000 m [Vinogradov, 1970a]. It is therefore very likely that the Crustaceans noted by Peres were not Euphausiacea, but Mysidacea [Vinogradov, 1968].

Cumacea

There are very few ultra-abyssal representatives of Cumacea known from depths to 8 km. They have been caught at 18 stations in 8 trenches and the Northeast trough of the Pacific Ocean, as well as in the Japan and South Sandwich trenches and the Scotia Sea. Only 2 new species have been described from the genus Makrokylindrus from collections from the Yavan and Japan trenches by expeditions on Galathea and Hakuho-Maru. Another 8 Cumacea representatives from the Vityaz collections were also defined by N. B. Lomakina as new species, but they have not been described. It is important that of the 6 specimens, 4 species classified as different genera and families were found in one trawling catch from depth 6,065 m in the Northeast trough of the Pacific Ocean (Vityaz, st. 4074). All the Cumacea that were defined as species had not been known from depths below 6,000 m. There is not a known more accurate taxonomic classification of Cumacea from the Soviet expedition or Vema collections. The list of Cumacea findings below 6,000 m is given in Appendix II, Table 11.

Tanaidacea

The Tanaidacea order is known from depths over 6,000 m from the majority of studied trenches of all three oceans (Appendix II, Table 12). They have been found at depths to 9 km. Collections from the expedition on Galathea and most of the collections from the Soviet expeditions have already been processed. The taxonomic composition of Tanaaidacea dwelling below 6,000 m is very diverse. Currently, 53 species of 15 genera and 9 families have been defined. The richest representation is from the family Leptognathiidae that includes 30 species of the 53 (57%), including 19 species of the genus Leptognathia, i.e., over 1/3 of all the Tanaidacea species known from these depths.

Despite the broad dissemination of Tanaidacea in the deep-sea trenches, there is the impression that they are distributed in the trenches very nonuniformly and sporadically. The frequency of encounter of Tanaidacea below 6 km in trawling catches (based on Soviet expedition and Galathea expedition collections) is somewhat less than 30%, and in the bottom grab samples, about 40%. There were 8 species (11 specimens) represented iin one trawling catch from the Northeast trough of the Pacific Ocean (Vityaz, st. 4074). In two catches from the Izu-Bonin trench obtained in the 57th trip of Vityaz from similar depths 6,770-6,850 and 6,770-6,890 m (st. 7404 and 7407), in the first there were 6 species (11 specimens) of Tanaidacea, and in the second, 5 species (56 specimens), while in the 4 catches from the same trench from depths between 7,300 and 8,900 m there were none.. In the bottom grab sample from the Aleutian trench from depth 6,520 m (Vityaz, st. 6139) there were 5 specimens of Tanaidacea of three species [Kudinova-Pasternak, 1973], and in the bottom grab sample from this same trench from depth 7,298 mm there were even more, 18 specimens or 72 specimens/m^2 [Jumars, Hessler, 1976].

Figure 29 shows the vertical dissemination of ultra-abyssal Tanaidacea. Based on the available data, the endemism of ultra-abyssal Tanaidacea averages 40%, but as is apparent from Fig. 29, B, it increases uniformly with depth from 16% in the level 6-6.5 km to 75% in the level 8-8.5 km; apparently, the only species found at depth about 9 km (Leptognathia longiremis?) is endemic for this depth. Attention is drawn to the high percentage of eurybathic species that are found

Figure 29. Vertical Distribution of Tanaidacea Known from Depths over 6 km (A) and Change with Depth in the Number of Species (1) and Endemic Percentage (2) (B)

in the depth range from sub-littoral or bathyal to ultra-abyssal (see Fig. 29, A). However, this vertical distribution is highly doubtful. At least one and a half of the dozen species known from depths over 6,000 m depths in the Pacific Ocean trenches have been determined by R. K. Kudinova-Pasternak as belonging to species that were already previously known from depths of the sub-littoral or bathyal in the Atlantic Ocean (most often in its northern part), while in the Pacific Ocean they are not encountered at all above 6,000 m or do not rise above the abyssal depths. It is extremely doubtful that with these hiatuses both in vertical and geographical dissemination, the Pacific Ocean and Atlantic forms could belong to the same species. It is difficult to allow that genetic differences did not emerge among such diverse and reprodutively isolated populations during their lengthy existence. Most likely, we are dealing here with twin-species, that as defined by E. Mayr are "morphologically similar or identical, but reproductively isolated populations" [Mayr, 1968, p. 42]. If we are dealing with different species in the discussed cases, then the number of so many eurybathic "species" is reduced approximately from 40 to 10%, and the number of abyssal-ultra-abyssal species rises from 20 to 50% with 40% endemics.

Based on the data of other authors [Wolff, 1965b; Lang, 1968], the range of vertical dissemination of the majority of deep-sea Tanaidacea does not exceed 2 km, and their geographical dissemination is limited only to one ocean or a more narrow region.

Tanaidacea genera endemic for the ultra-abyssal regions are not known. The genus Herpotanais Wolff, whose only species H. kirkegaardi was described from the Kermadec trench from depth about 7 km [Wolff, 1956b]), was considered for a long time to be endemic to this trench. But in 1973, a second species of this genus, H. birsteini [Kudinova-Pasternak, 1973a] was described form the northwest Pacific Ocean from depth 4,954 m.. The monotypic genus Arthrura Kud.-Past is only known in the depth range from 4,000 to 6,065 m.

An interesting finding was made in two trawling catches from the Philippine trench from depths 6,290 to 7,880 m of 77 specimens endemic for this trench of the species Gigantapseudes adactylus (Fig. 30) isolated into individual genera and the family Gigantapseudidae [Kudinova-Pasternak, 1978]. The body length of this species reaches 37 mm and is 1.5 times longer than the length of the previously largest known representatives of this order. However, even larger representatives of this genus, G. maximus (length to 75 mm!) were described from depths 5,460 to 5,567 m from five locations

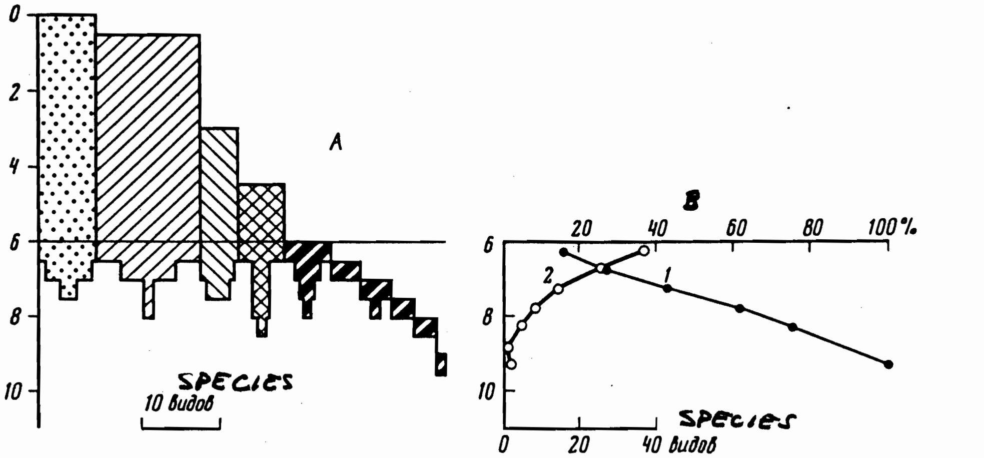

Рис. 29. Вертикальное распространение Tanaidacea, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

ся в диапазоне глубин от сублиторали или батиали до ультраабиссали (см. рис. 29,*А*). Однако такое вертикальное распространение вызывает серьезные сомнения. По крайней мере полтора десятка видов, известных с глубин более 6000 м в желобах Тихого океана, определены Р.К. Кудиновой-Пастернак как относящиеся к видам, которые уже были известны ранее с глубин сублиторали или батиали в Атлантическом океане (чаще всего в его северной части), тогда как в Тихом океане они вообще не встречены выше 6000 м или не поднимаются выше абиссальных глубин. Чрезвычайно сомнительно, чтобы при таких хиатусах как по вертикальному, так и по географическому распространению тихоокеанские и атлантические формы могли бы принадлежать к одним и тем же видам. Трудно допустить, чтобы при длительном существовании столь разобщенных и репродуктивно изолированных популяций между ними не возникло генетических различий. Скорее всего, мы в этих случаях имеем дело с видами-двойниками, которые, по определению Э.Майра, представляют собой "морфологически сходные или идентичные, но репродуктивно изолированные популяции" [Майр, 1968, с. 42]. Если в обсуждаемых случаях мы имеем дело с разными видами, то число столь эврибатных "видов" сократится примерно с 40 до 10%, а число абиссально-ультраабиссальных видов возрастет с 20 до 50% при 40% эндемиков.

По данным других авторов [Wolff, 1965b; Lang, 1968], для большинства глубоководных танаид диапазон их вертикального распространения не превышает 2 км, а географическое распространение ограничено только одним океаном или более узким районом.

Эндемичных для ультраабиссали родов танаид не известно. Род Herpotanais Wolff, единственный вид которого H. kirkegaardi был описан из желоба Кермадек с глубины около 7 км [Wolff, 1956b], долгое время считался эндемиком этого желоба. Но в 1973 г. из северо-восточной части Тихого океана с глубины 4954 м был описан второй вид этого рода – H. birsteini [Кудинова-Пастернак, 1973a]. Монотипический род Arthrura Kud.-Past. известен лишь в диапазоне глубин от 4000 до 6065 м.

Интересно нахождение в двух траловых уловах из Филиппинского желоба с глубин от 6290 до 7880 м 77 экз. эндемичного для этого желоба вида Gigantapseudes adactylus (рис. 30), выделенного в отдельные род и семейство Gigantapseudidae [Кудинова-Пастернак, 1978]. Длина тела рачков этого вида достигает 37 мм и в полтора раза превышает длину самых крупных из известных ранее представителей этого отряда. Однако в дальнейшем еще более крупные представители этого рода – G. maximus (длина до 75 мм!) – были описаны с глубин от 5460 до 5567 м из пяти местонахожде-

Figure 30. Isopoda (1, 2) and Tanaidacea (3, 4) from Vityaz Collections

Key:
1. Storthyngura hercules, st. 2208, depth 7,210-7,230 m
2. Hydroniscus sp., st. 7300, depth 7,190-7,250 m
3. Neotanais insignus, st. 7371, depth 8,215-8,255 m
4. Gigantapseudes adactylus, st. 7206, depth 7,420-7,880 m (per: Research vessel Vityaz, 1983). Scale lines equal 1 cm

somewhat to the east of the southern Philippine trench [Gamo, 1984], i.e., close to the location of the hadal species G. adactylus. This genus and family are thus endemic for a narrow local region and depths from 5,460 to 7,880 m. The other Tanaidacea genera that are known from depths over 6 km are eurybathic.

The Tanaidacea, typically benthic animals, are usually confined to the surface layer of the bottom sediments. However, it was found that some Tanaidacea are capable of floating, and even rise considerable distances above the bottom. Leptognatha sp. was once caught in the Kuril Kamchatka trench by a plankton net in the level 8,700-7,000 m no less than 50-100 m above the bottom. A Crustacean of the same genus close to L. breviremis was found in the intestine of an Ascidia caught in the same trench at depth 7,265-7,295 m; it could have fallen into the Ascidia siphon that was only in the benthic water layer.

Isopoda

Isopoda is one of the groups that are very characteristic for hadal ocean depths. The number of Isopoda species found below 6,000 m is greater than the species of any other order of Crustacea and any

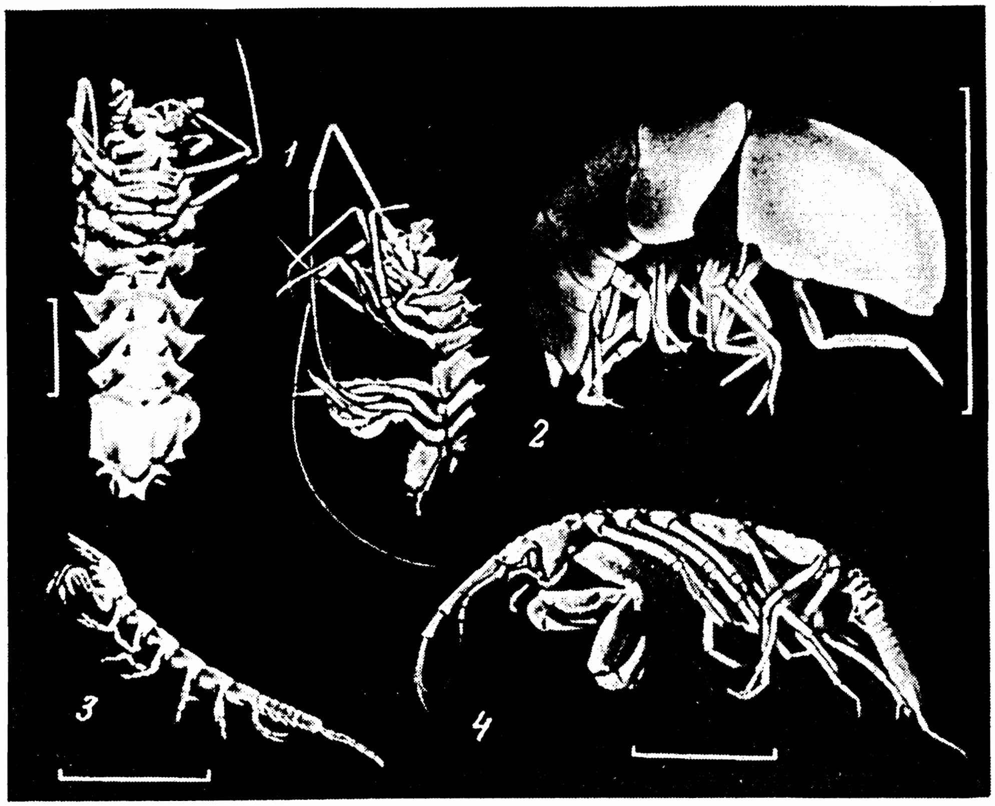

Рис. 30. Равноногие ракообразные (*1*, *2*) и танаиды (*3*, *4*) из сборов "Витязя"

1 – Storthyngura herculea, ст. 2208, гл. 7210–7230 м; *2* – Hydroniscus sp., ст. 7300, гл. 7190–7250 м; *3* – Neotanais insignus, ст. 7371, гл. 8215–8225 м; *4* – Gigantapseudes adactylus, ст. 7206, гл. 7420–7880 м (по: "Научно-исследовательское судно "Витязь" , 1983). Масштабные линейки равны 1 см

ний несколько восточнее южной части Филиппинского желоба [Gamô, 1984], т.е. близко от местонахождений хадального вида G. adactylus. Таким образом, эти род и семейство пока эндемичны для узколокального района и глубин от 5460 до 7880 м. Остальные роды танаид, известных с глубин более 6 км, эврибатные.

Танаиды – типично донные животные, обычно приуроченные к поверхностному слою донных осадков. Оказалось, однако, что некоторые танаиды способны всплывать и даже подниматься на значительное расстояние над дном. Рачок Leptognathia sp. однажды был пойман в Курило-Камчатском желобе планктонной сетью в горизонте 8700–7000 м не менее чем в 50–100 м над дном. Рачок того же рода, близкий к L. breviremis, был найден в кишечнике асцидии, пойманной в том же желобе на глубине 7265–7295 м; попасть в сифон асцидии он мог, только находясь в придонном слое воды.

Равноногие – Isopoda

Изоподы – одна из групп, чрезвычайно характерных для больших океанических глубин. Число видов изопод, найденных глубже 6000 м, больше, чем видов любого другого отряда ракообразных и любого другого класса многоклеточных животных. К настоящему времени полностью обработаны сборы экспедиции на "Галатее" и большая часть сборов советских экспедиций (кроме экспедиций последних 10–15 лет); определены 122 таксона видового ранга и известны еще по крайней мере 2–3 десятка

other class of multicellular animals. Collections from the Galathea expedition have been completely processed by now and most of the collections of the Soviet expeditions (except the expeditions of the last 10-15 years); 122 taxons have been defined of species rank and at least another 2-3 dozen species are known

TABLE 14. GREATEST DEPTHS OF FINDING AND NUMBER OF GENERA AND SPECIES FOUND BELOW 6,000 m IN VARIOUS SUB-ORDERS AND FAMILIES OF THE ISOPODA ORDER

Key:
1. Suborder and family
2. Greatest depth, m
3. Number of genera
4. Number of species (including subspecies)
5. Number of findings below 6,000 m

that have only been defined to the genus or family (Appendix II, Table 13). The frequency of encounter of Isopoda in the trawling catches is about 70%, and 36% in the bottom grab samples. Isopoda have been found in almost all of the examined trenches and troughs, and at all depths, all the way to 10,700 m in the Mariana trench. There were few Isopoda in the majority of catches, e.g., in the very rich and representative bottom grab sample from the Aleutian trench (7,298 m) in which there were dozens of animals of a number of groups, and some over 100 specimens, there were only 2 Isopoda specimens [Jumars, Hessler, 1976]. But in a number of cases, their number in the trawling catches reached several dozen specimens belonging to several species, and they comprised 10-40% of the entire haul in population. All the cases of such mass finding belong to large representatives of two genera, Eurycope and Storthyngura, in the trenches of the northwest Pacific Ocean (Kuril-Kamchatka, Japan, Izu-Bonin). Thus, for example, in the trawling catch from the Japan trench from a depth about 6,200 m (Vityaz, st. 3214) there were 159 specimens (7 species, including 150 specimens of S. biocornis) which comprised 27% of the total number of animals caught: in the catch from depth about 7,200 m in the same trench (st. 3227), 9 specimens, or 41% were Isopoda of two species, including 8 S. herculea, and at depth about 8

Таблица 4

Наибольшие глубины нахождения и число родов и видов, найденных глубже 6000 м в разных подотрядах и семействах отряда Isopoda

Подотряд и семейство 1	Наибольшая глубина, м 2	Число родов 3	Число видов (включая подвиды) 4	Число нахождений глубже 6000 м 5
Anthuridea				
Anthuridae	6580	1	2	2
Asellota				
Desmosomatidae	6700	1	2	2
Echinothambematidae	6850	1	1	5
Eurycopidae	9345	6	30	75
Haploniscidae	10687	3	18+	37
Ilyarachnidae	10687	1	8	18
Ischnomesidae	8580	4	24	40
Janirellidae	8000	1	8	14
Janiridae	7000	1	3+	12
Macrostylidae	10700	1	15+	30
Mesosignidae	7880	1	3+	12
Munnidae	6450	3	3	3
Munnopsidae	8225	?	?	4
Nannoniscidae	9000	5	7	12
Flabellifera				
Cirolanidae	6134	1	1	1
Serolidae	5650–6070	1	?	1
Valvifera				
Arcturidae	7230	2	4+	7

видов, пока определенных лишь до рода или до семейства (Приложение II, табл. 13). Частота встречаемости изопод в траловых уловах составляет около 70%, а в дночерпательных пробах – 36%. Изоподы найдены почти во всех обследованных желобах и котловинах и на всех глубинах вплоть до глубины 10 700 м в Марианском желобе. В большинстве уловов изоподы были немногочисленны. Так, например, в очень богатой и представительной дночерпательной пробе из Алеутского желоба (7298 м), в которой животные ряда групп были представлены десятками, а некоторых – более чем 100 экз. оказалось лишь 2 экз. изопод [Jumars, Hessler, 1976]. Но в ряде случаев их число в траловых уловах достигало нескольких десятков экземпляров, принадлежащих к нескольким видам, и они составляли 10–40% всего улова по численности. Все случаи такого массового нахождения относятся к крупным представителям двух родов – Eurycope и Storthyngura – в желобах северо-западной части Тихого океана (Курило-Камчатском, Японском, Идзу-Бонинском). Так, например, в траловом улове из Японского желоба с глубины около 6200 м ("Витязь", ст. 3214) было 159 экз. (7 видов, в том числе 150 экз. S. bicornis), что составляло 27% общего числа пойманных животных: в улове с глубины около 7200 м в том же желобе (ст. 3227) – 9 экз., или 41% составляли изоподы двух видов, в том числе 8 – S. herculea, а на глубине около 8 км в Курило-Камчатском желобе (ст. 5616) – 44 экз., или 13% улова составляли 2 вида (40 – S. vitjazi и 4 – Euricope magna).

Подавляющее большинство найденных глубже 6000 м видов (так же как и среди глубоководных изопод вообще [Хэсслер, Уилсон, 1988]) относятся к подотряду Asellota, представленному 13 семействами и 29 родами. В пределах этого подотряда наиболее характерны и разнообразны уже упомянутые два рода семейства Eurycopidae (12 видов Eurycope и 13 – Storthyngura), проникающие до глубин более 9 км. Представители трех семейств проникают до наибольших глубин (более 10 км). Два из

km in the Kuril-Kamchatka trench (st. 5616) 44 specimens, or 13% of the catch comprised 2 species (40 S vitjazi and 4 Euricope magna).

The overwhelming majority of the species found below 6,000 m (in the same way as among the deep-sea Isopoda in general [Hessler, Wilson, 1988] belong to the suborder Asellota represented by 13 families and 29 genera. Within this suborder the most characteristic and diverse are the aforementioned two genera of the family Eurycopidae (12 species of Eurycope and 13 Storthyngura) that penetrate to depths over 9 km. Representatives of these three families penetrate to the greatest depths (over 10 km). Two of

Figure 31. Vertical Dissemination of Isopoda Known from Depths over 6 km (A), and Change with Depth in Number of Species (1) and Percentage of Endemics (2) (B)

them are represented below 6 km each by species of only one genus, Janirella (Janirellidae) and Macrostylis (Macrostylidae), while a third, Haploniscidae, is represented by three genera, but the majority of the species belong to the deepest sea genus Haploniscus. There are few representatives of other suborders at depths over 6,000 m and they do not penetrate below 6.5-7.5 km. Table 4 cites data on the taxonomic diversity and the greatest dwelling depths of various families of Isopoda.

Isopoda were found several times on bottom photographs from depths to 8 km in the Palau, Bougainville and New Hebrides trenches [Lemche et al., 1976].

The vertical distribution of ultra-abyssal Isopoda is shown in Fig. 31. It is apparent from this figure that the species endemic for depths over 6 km comprise 63%, the abyssal-hadal species over 35%, and only two species (about 1.5%) eurybathic dwelling in the range from 2,400 to 6,100-6,200 m. Of the species that are endemic for the ultra-abyssal depths, about 75% are known only from one finding, which does not allow an opinion about their vertical dissemination range. But, judging from the endemic species that are known from several findings, a great stenobathic level is inherent to them, 50% of them have a vertical range less than 1,000 m, 40% from 1 to 2 km, and only 10% from 2 to 3 km. Among the species that are not endemic for depths over 6,000 m, there is also a dominance of stenobathic species with vertical range less than 1,000 or 2,000 m (54%); species with range from 2 to 3 km are 29% and only 17% more eurybathic species, among which, however, there is none with a vertical range that exceeds 4 km.

There is weak endemism of the genus rank. Of the 34 genera, only 3 are endemic: Austroniscoides Birstein, whose only species A. bougainvillei was found three times in the Bougainville trench at depths from 6,900 to 9,000 m, and another two monotypical genera from the same family Nannoniscidae from the Puerto Rico and Cayman trenches indicated by T. Wolff as new [Wolff, 1975; Wolff, 1979], but their diagnoses have not yet been published.

The Isopoda are a good example of ultra-abyssal fauna endemism in individual trenches or neighboring trenches combined by depths about 6 km, as well as the relationship of fauna in the trenches and abyssal of their neighboring ocean regions. In the chain of the Pacific Ocean northwest trenches Aleutian - Kuril-Kamchatka - Japan - Izu-Bonin there are 18 known ultra-abyssal endemic species that are inherent to only one of these trenches, 8 species common for two or three of these trenches, and

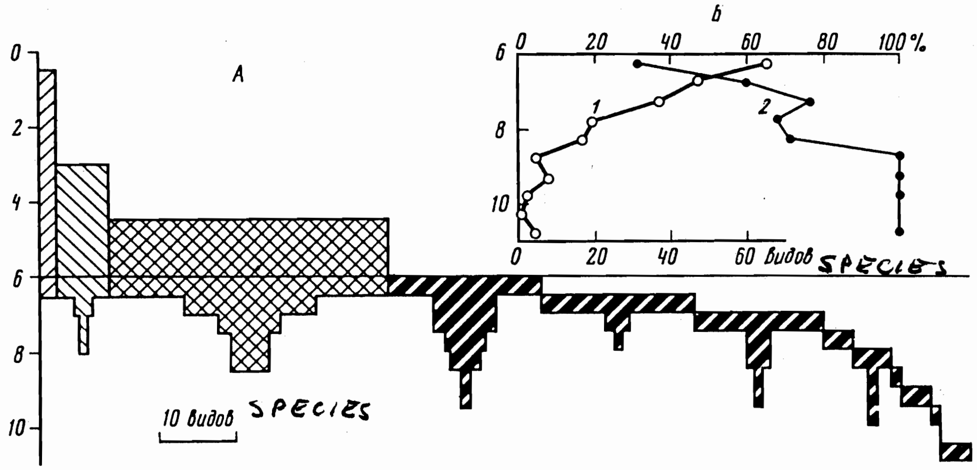

Рис. 31. Вертикальное распространение Isopoda, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

них представлены глубже 6 км каждое видами лишь одного рода – Janirella (Janirellidae) и Macrostylis (Macrostylidae), а третье – Haploniscidae – представлено тремя родами, но большинство видов относятся к наиболее глубоководному роду Haploniscus. Представители других подотрядов на глубинах более 6000 м немногочисленны и не проникают глубже 6,5–7,5 км. В табл. 4 приведены данные по систематическому разнообразию и наибольшим глубинам обитания разных семейств равноногих ракообразных.

Несколько раз изоподы были обнаружены на фотографиях дна, полученных на глубинах до 8 км в желобах Палау, Бугенвильском и Ново-Гебридском [Lemche et al., 1976].

Вертикальное распределение ультраабиссальных изопод показано на рис. 31. Как видно из этого рисунка, эндемичные для глубин более 6 км виды составляют 63%, абиссально-хадальные виды – более 35% и лишь два вида (около 1,5%) эврибатные, обитающие в диапазоне от 2400 до 6100–6200 м. Из видов, эндемичных для ультраабиссальных глубин, около 75% известны лишь по одному нахождению, что не позволяет судить о диапазоне их вертикального распространения. Но, судя по эндемичным видам, известным по нескольким нахождениям, им свойственна большая стенобатность – 50% из них имеют вертикальный диапазон менее 1000 м, 40% – от 1 до 2 км и лишь 10% – от 2 до 3 км. Среди видов, не эндемичных для глубин более 6000 м, также преобладают стенобатные виды с вертикальным диапазоном менее 1000 или 2000 м (54%), виды с диапазоном от 2 до 3 км составляют 29% и лишь 17% – более эврибатные виды, среди которых, однако, нет ни одного с вертикальным диапазоном, достигающим 4 км.

Эндемизм родового ранга выражен слабо. Из 34 родов эндемичны только 3: Austroniscoides Birstein, единственный вид которого A. bougainvillei найден трижды в Бугенвильском желобе на глубинах от 6900 до 9000 м, и еще два монотипических рода из того же семейства Nannoniscidae из желобов Пуэрто-Рико и Кайман, указанные Т. Вольфом как новые [Вольф, 1975; Wolff, 1979], но диагнозы их пока не опубликованы.

На примере изопод хорошо прослеживается эндемизм ультраабиссальной фауны отдельных желобов или соседних желобов, объединенных глубинами около 6 км, а также родство фаун желобов и абиссали соседних с ними районов океана. В цепочке северо-западных желобов Тихого океана Алеутский – Курило-Камчатский – Японский – Идзу-Бонинский известно 18 видов-эндемиков ультраабиссали, свойственных только одному из этих желобов, 8 видов, общих для двух или трех из этих желобов, и

27 species that are not endemic for the ultra-abyssal, but that are known beyond these trenches only from the abyssal of the northwest Pacific Ocean adjoining it. From the Kermadec trench 10 species endemic for it and 3 species encountered in the adjoining ocean region at abyssal depths have been described for it. Only three endemic species are known from the Tonga trench; from the Bougainville 7 endemic species that are not known anywhere beyond its limits; from the Peru 1 endemic species and 5 species found in the abyssal of the region adjoining the trench. From the Puerto Rico trench there are 9 known endemics and 6 species that dwell in the abyssal of the adjoining region; from the Cayman trench, 3 endemics and 1 species that are also disseminated in the Caribbean Sea abyssal. Finally, from several trenches (Banda, Philippine, Mariana, Yavan, Romanche and South Sandwich) only species endemic for each of these trenches have been defined. Isopoda species that are common for several very dispersed trenches have not yet been found.

Figure 32. Vertical Dissemination of Amphipoda Known from Depths over 6 km (A) and Change with Depth in Number of Species (1) and Percentage of Endemics (2) (B)

These data graphically indicate the high degree of species endemism of Isopoda ultra-abyssal fauna of each trench or group of adjoining trenches, and the origin of the fauna of each trench from the deep-sea fauna of the ocean region neighboring this trench.

Amphipoda

The Amphipoda, in the same way as the Isopoda, comprise a very characteristic fauna element in the trenches in which they dwell all the way to the greatest depths, over 10.5 km. They are encountered in all the studied trenches. The frequency of encounter of Amphipoda in the trawling catches is 70% (based on the data of 124 successful trawlings for which there is known information on the group composition of the catches). Among the Amphipoda caught below 6 km, there are 20 known real pelagic species (species of the suborder Hyperiidea, and from the suborder Gammaridea Crustaceans of the family Hyperiopsidae and some representatives of other families). Additionally, it is possible that several pelagic species live below 6 km, each of which were only caught once in an open catch from depths over 6,000 m to the surface.

27 видов, не эндемичных для ультраабиссали, но известных за пределами этих желобов только из абиссали прилегающей к ним северо-западной части Тихого океана. Из желоба Кермадек описаны 10 эндемичных для него видов и 3 вида, встреченных в прилегающем к нему районе океана на абиссальных глубинах. Из желоба Тонга известны только 3 эндемичных для него вида; из Бугенвильского – 7 эндемичных видов, не известных нигде за его пределами; из Перуанского – 1 эндемичный вид и 5 видов, встреченных в абиссали прилегающего к желобу района. Из желоба Пуэрто-Рико известны 9 эндемиков и 6 видов, обитающих и в абиссали прилегающего к нему района; из желоба Кайман – 3 эндемика и 1 вид, распространенный также в абиссали Карибского моря. Наконец, из нескольких желобов (Банда, Филиппинский, Марианский, Яванский, Романш и Южно-Сандвичев) пока определены только виды, эндемичные для каждого из этих желобов. Виды изопод, общие для нескольких далеко разобщенных желобов, пока не обнаружены.

Приведенные данные наглядно свидетельствуют о высокой степени видового эндемизма ультраабиссальной фауны изопод каждого желоба или группы смежных желобов и о происхождении фауны каждого желоба от глубоководной фауны соседнего с данным желобом района океана.

Разноногие, или бокоплавы, – Amphipoda

Амфиподы, так же как и изоподы, составляют весьма характерный элемент фауны желобов, в которых они обитают вплоть до наибольших глубин – более 10,5 км. Они встречены во всех обследованных желобах. Частота встречаемости амфипод в траловых уловах составляет 70% (по данным 124 удачных тралений, для которых известны сведения по групповому составу уловов). Среди амфипод, пойманных глубже 6 км, известны 20 настоящих пелагических видов (виды подотряда Hyperiidea, а из подотряда Gammaridea рачки семейства Hyperiopsidae и некоторые представители других семейств). Кроме того, возможно, обитают глубже 6 км еще несколько пелагических видов, каждый из которых был пойман лишь однажды при сквозном лове с глубин более 6000 м до поверхности.

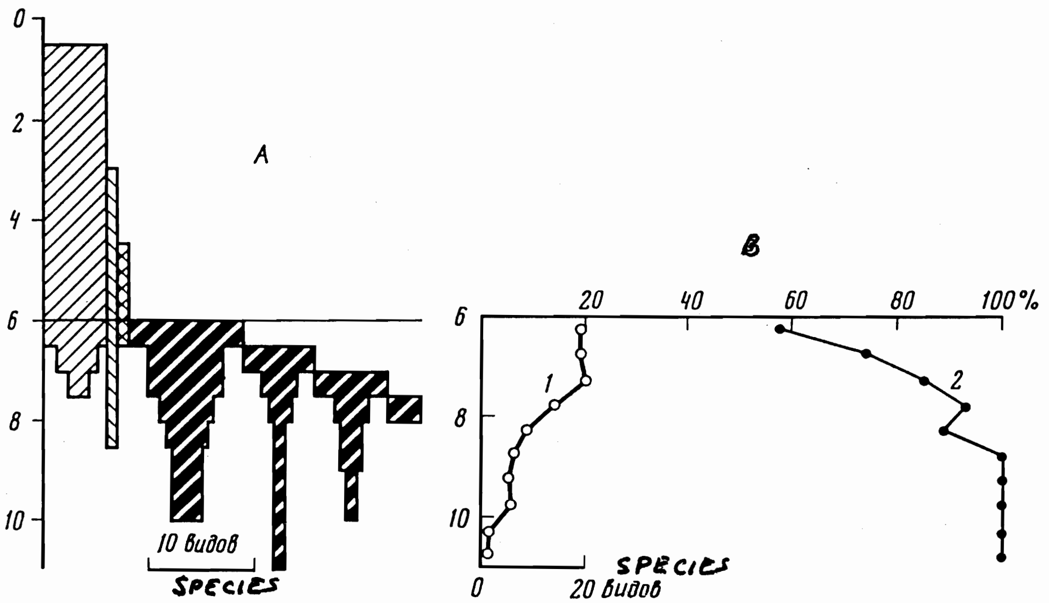

Рис. 32. Вертикальное распространение Amphipoda, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

Figure 33. Autonomous Benthic Traps with Bait (A) and Bait Lowered Independently to the Bottom (Fish Bundle) and Its Monitoring Camera with Flash and Pinger (B) [per: Wolff, 1976a]

Of the real benthic species and bottom-dwellers mainly due to the nature of eating, but capable of freely floating and rising to considerable distances above the bottom, there are 36 known species (and another 2, only defined to the genus), of which 78% have not been found above 6 km. Of these endemics, half of the species are only known by one finding, and half, by several or many findings. Among the pelagic species of the trenches the endemics are known from several findings. The list of Amphipoda known from depths over 6 km is given in Appendix II, Table 14, while the nature of vertical dissemination of the benthic and near-bottom species and change with depth in the number of species and degrees of species endemism are shown in Fig. 32. As is apparent, the percentage of endemics increases naturally as the depth increases.

In the Kuril-Kamchatka trench and in 6 trenches surrounding the Philippine Sea, at their greatest depths, including below 10 km, apparently the only mass species of Amphipoda is Hirondellea gigas. The Crustacea of this species are known in numerous catches, but none were ever caught at depths less than 6,770 m. It is true that

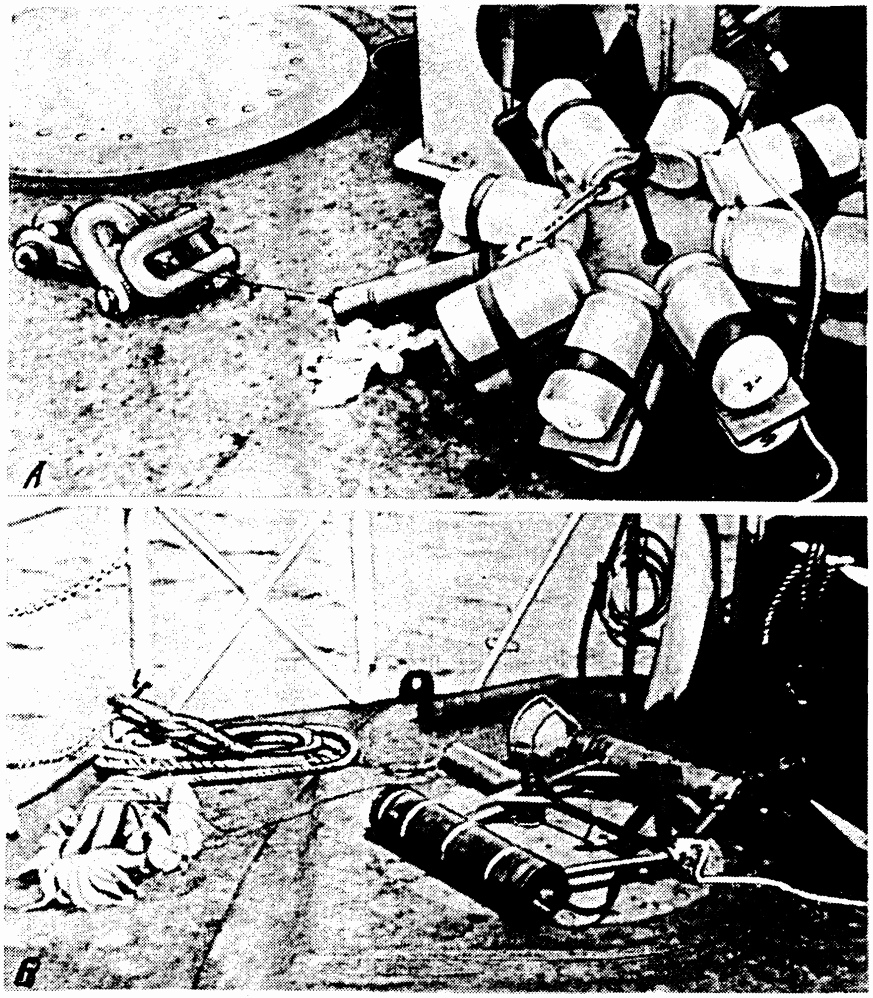

Рис. 33. Автономные донные ловушки с приманкой (*А*) и опускаемые автономно на дно приманка (связка рыб) и контролирующая ее фотокамера со вспышкой и пинджером (*Б*) [по: Wolff, 1976а]

Из настоящих донных видов и придонных, связанных с дном, главным образом по характеру питания, но способных хорошо плавать и подниматься на значительные расстояния над дном, известны 36 видов (и еще 2, определенные лишь до рода), из которых 78% не найдены выше 6 км. Из числа этих эндемиков половина видов известна лишь по одному нахождению, а половина – по нескольким или многим нахождениям. Среди пелагических видов эндемиков желобов меньше – они составляют 44%, но 5 из 8 эндемичных видов известны по нескольким нахождениям. Список амфипод, известных с глубин более 6 км, приведен в Приложении II, табл. 14, а характер вертикального распространения донных и придонных видов и изменение с глубиной числа видов и степени видового эндемизма показаны на рис. 32. Как видно, процент эндемиков закономерно возрастает по мере увеличения глубины.

В Курило-Камчатском желобе и в 6 желобах, окружающих Филиппинское море, на их наибольших глубинах, в том числе глубже 10 км, по-видимому, единственный массовый вид амфипод – Hirondellea gigas. Рачки этого вида известны по многочисленным ловам, но ни разу не были пойманы на глубинах менее 6770 м. Правда, судить

Figure 34. Amphipoda Hirondellea gigas Caught in Self-Contained Traps with Bait in the Philippine Trench at Depth 9,604 m (a) and Fish Skeleton Gnawed Clean by Amphipoda H.-gigas in the Same Place (b) [per: Wolff, 1976a]

it is difficult to judge the real range of the vertical distribution of many benthic-pelagic Amphipoda species found below 6 km, since they are very mobile and easily avoid the catching equipment. Thus, for example, in the Philippine trench the Galathea expedition made 4 trawlings at depths 9,820-10,210 m and 4 specimens of H. gigas were found in only two of them, and in 8 trawling catches of Vityaz from depths 6,300 to 9,990 m in this same trench, Crustaceans of this species were missing altogether, and in 13 bottom grab samples and 8 trawling catches obtained here by the American expeditions. In addition to these benthic catches with bait (Fig. 33) lowered to depth 9,604 m (Thomas Washington, st. H-186), over 4,000 H. gigas were caught

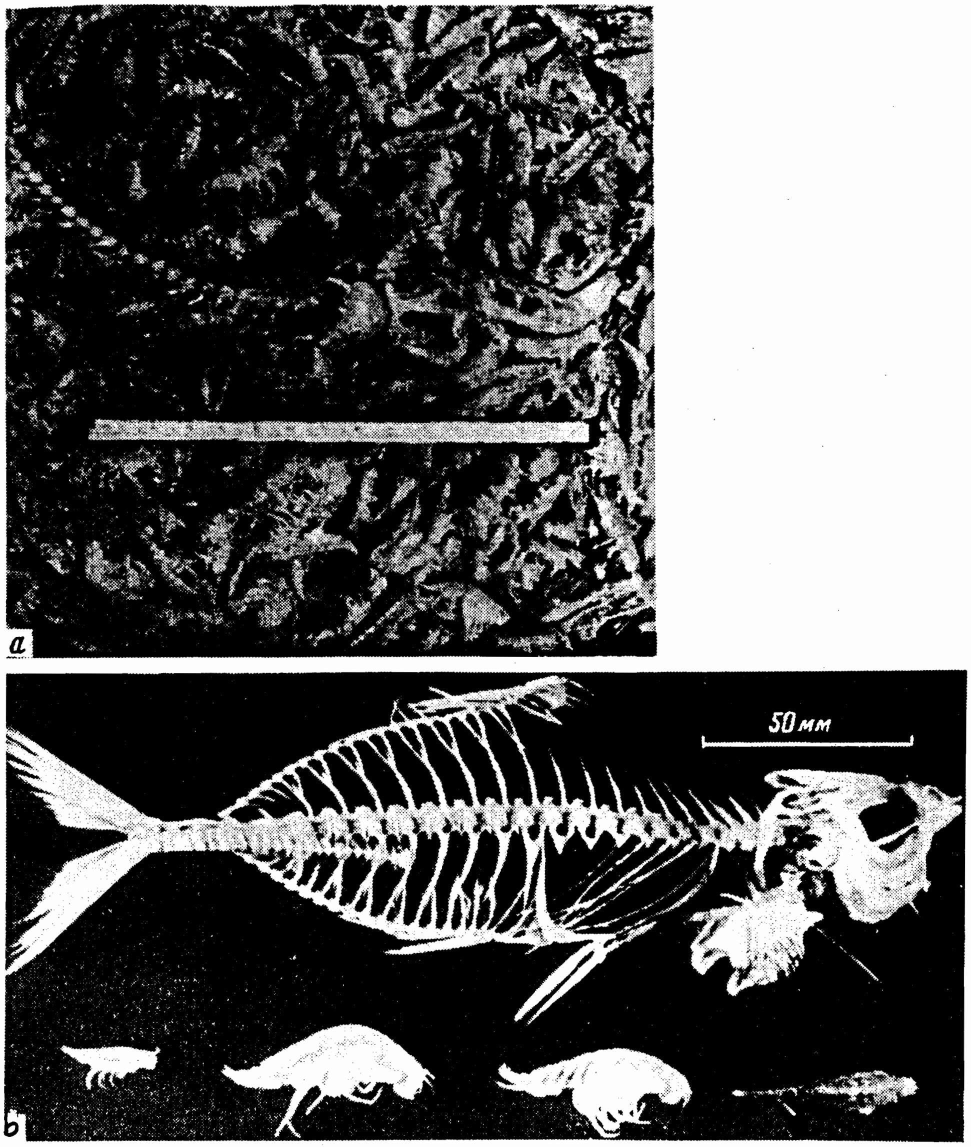

Рис. 34. Амфиподы Hirondellea gigas, пойманные в автономные ловушки с приманкой в Филиппинском желобе на глубине 9604 м (*а*) и скелет рыбы, начисто обглоданный амфиподами H. gigas, там же (*б*) [по: Wolff, 1976a]

о действительном диапазоне вертикального распространения многих встреченных глубже 6 км бенто-пелагических видов амфипод трудно, так как они очень подвижны и легко избегают орудия лова. Так, например, в Филиппинском желобе экспедицией на "Галатее" было проведено 4 траления на глубинах 9820–10210 м и только при двух из них были пойманы 4 экз. H. gigas, а в 8 траловых уловах "Витязя" с глубин от 6300 до 9990 м в этом же желобе рачки этого вида вообще отсутствовали, так же как и в 13 дночерпательных пробах и 8 траловых уловах, полученных здесь американскими экспедициями. Наряду с этим донными ловушками с приманкой (рис. 33), опущенными на глубину 9604 м ("Томас Вашингтон", ст. Н-186), были пойманы больше 4 тыс.

Figure 35. Amphipoda Hirondellea gigas Collected on Bait Lowered to the Bottom on a Self-Contained Instrument-Carrier

Key:

a. within 2 hours
b. within 12 hours after lowering of the bait in the Philippine trench to depth 9,604 m, photograph from distance 2.44 m
c. the same at another station at depth 9,605 m within 6 hours 40 minutes after lowering of the bait, photograph from distance 1.22 m
d. at depth 5,861 m on the slope of the Philippine trench on bait only fish were collected of the family Brotulidae [per: Hessler et al., 1978]

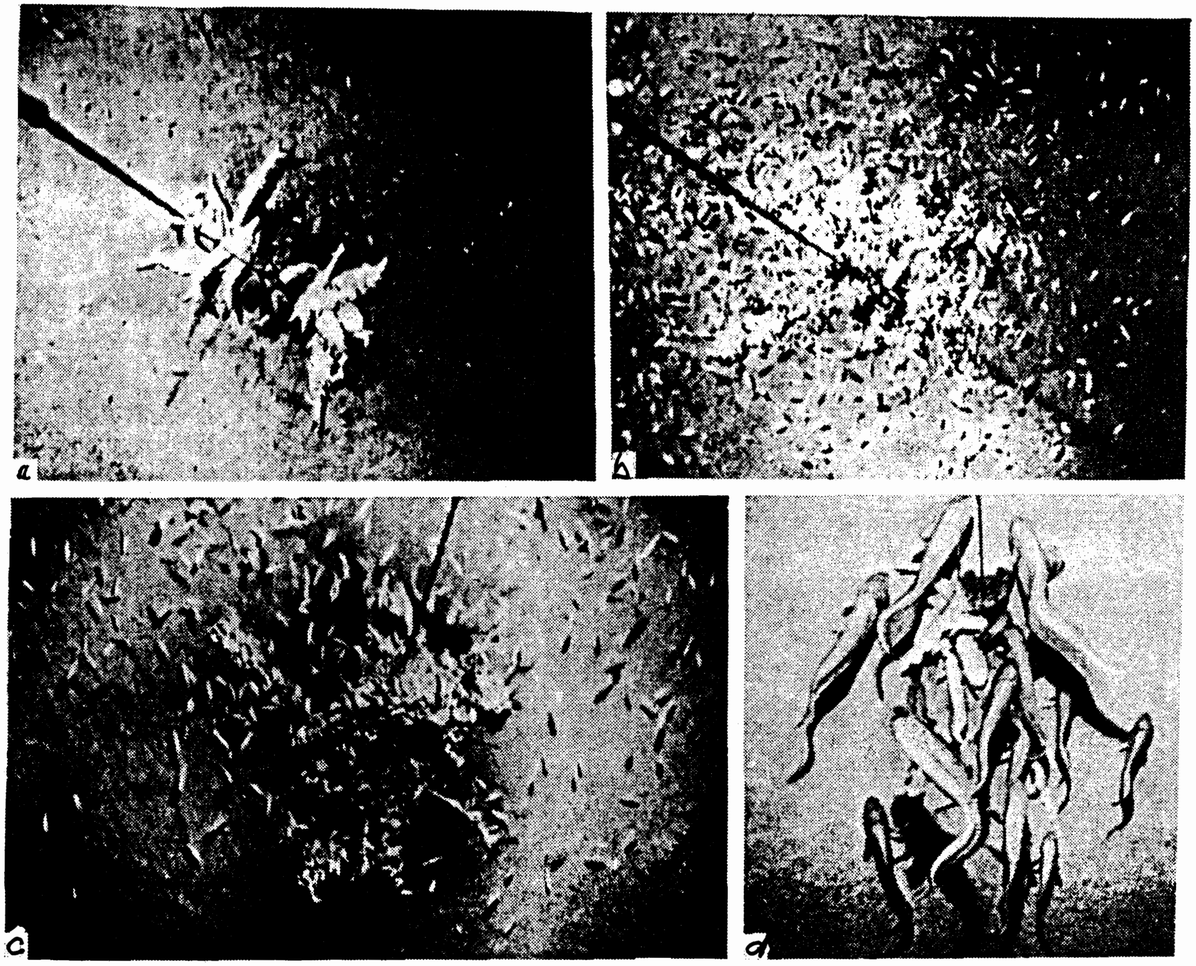

Рис. 35. Амфиподы Hirondellea gigas, собирающиеся на опущенную на автономном приборносителе на дно приманку

а — через 2 ч; *б* — через 12 ч после спуска приманки в Филиппинском желобе на глубину 9604 м, съемка с расстояния 2,44 м; *в* — то же на другой станции на глубине 9605 м через 6 ч 40 мин после спуска приманки, съемка с расстояния 1,22 м; *г* — на глубине 5861 м на склоне Филиппинского желоба на приманку собираются только рыбы сем. Brotulidae [по: Hessler et al., 1978]

P.29

Figure 36. Attraction of Benthic Animals to Bait Monitored by Camera in the Chile Trench

Key:
1. depths to 4,600 m, fish mainly gathered on the bait (upper photo)
2. depths from 6,767 to 7,196, Amphipoda gathered on the bait (lower photo)
Numbers from the left are station numbers of the research vessel Thomas Washington. Numbers from the right are the depths, m [per: Hessler et al., 1978]

(Figure 34), while the photographs that monitored the bait lowered to the bottom at these depths (Fig. 35) demonstrated that many thousands of these Crustaceans gathered near it [Hessler et al., 1978]. Hessler et al. note that abundant catches of these Amphipoda by bait traps were also made at depths from 7 to 10.6 km in the Mariana trench.

Insofar as H. gigas have been found in various trenches separated by depths less than

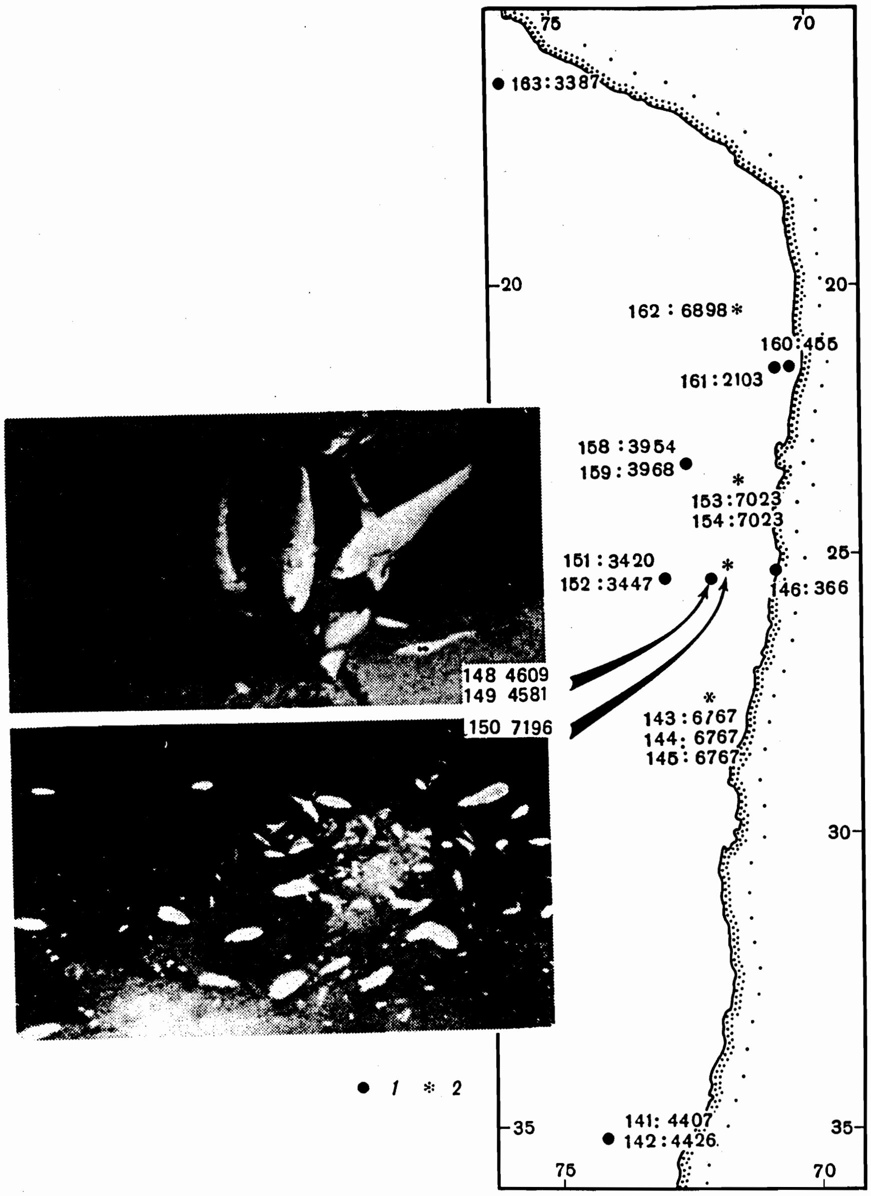

Рис. 36. Привлечение придонных животных на приманку, контролируемую фотокамерой в Чилийском желобе

1 – глубины до 4600 м, на приманку собирались главным образом рыбы (верхнее фото); 2 – глубины от 6767 до 7196 м, на приманку собирались амфиподы (нижнее фото). Числа слева – номера станций э/с "Томас Вашингтон", справа – глубины, м [по: Hessler et al., 1978]

H. gigas (рис. 34), а фотографии, контролировавшие опускаемые на дно на таких же глубинах приманки (рис. 35), показали, что около них собирались многие тысячи этих рачков [Hessler et al., 1978]. Хесслер с соавторами отмечают, что обильные ловы этих амфипод ловушками с приманкой были проведены также на глубинах от 7 до 10,6 км в Марианском желобе.

Поскольку H. gigas встречены в разных желобах, разобщенных глубинами менее

6 km, but have not yet been caught beyond the trenches, it is still not clear whether they dwell as isolated specimens in different trenches, or still not morphologically distinguished populations of this species (or very close species), or are these Crustaceans capable of penetrating from one trench to another, rising to depths less than 6 km. Mass clusters of Amphipoda near bait lowered to the bottom were also observed in the Chile trench (Fig. 36) at several stations at depths from 6,767 to 7,196 m [Hesssler et al., 1978]. In this same trench, Amphipoda were caught in both trawling catches made at depths 7,000 and 7,720 m (Akademik Kurchatov, st. 244 T-1 and T-2), but a more accurate taxonomic classification of Amphipoda from this trench has not yet been defined.

Amphipoda have also been repeatedly noted on photographs of the floor obtained in the trenches of the western tropical Pacific Ocean [Lemche et al., 1976].

Amphipoda found below 6,000 m belong to 15 families and 33 genera of the suborder Gammaridea and 2 families and 3 genera of the suborder Hyperiidea. Of the 28 genera of the first suborder that include benthic and bottom-dwelling species, 3 genera are endemic for depths over 6 km: Bathyschraderia Dahl, including 2 species known from 11 findings in the Philippine and Kermadec trenches; Metaceradocoides Birst. et Vinogradova, a monotypical genus that is known from 5 findings in 4 trenches of the western Pacific Ocean; and Steleuthera Barnard, a monotypical genus that is known from a single finding in the Peru trench. The endemism of the benthic and bottom-dwelling Amphipoda on the genus level is 11%. Among the pelagic Amphipoda there are no endemic ultra-abyssal genera.

At one of the Vityaz stations (st. 4355) in the northwest trough of the Pacific Ocean trawling and bottom grab samples were obtained from depth 6051 m. There were very small Amphipoda of a third suborder, Caprillidea (respectively 7 and 3 specimens) in both of these samples. Crustaceans of this suborder were found for the first time at that depth. They were previously not known from depths over 4,000 m [McCain, 1966]. Unfortunately, these Caprillidea were lost and their more accurate taxonomic classification remained unknown.

Decapoda

The most reliably known dwelling depths of the benthic Decapoda (suborder Reptantia) only slightly exceed depth 5 km. At depth 5,160 m in the Celebes Sea Parapagurus sp. [Wolff, 1970] was caught, and at depth 5,035-5,210 m in the northwest Pacific Ocean, Munidopsis subsquamosa latimana Birst. et Zarenkov [Birstein, Zarenkov, 1970]. Three specimens of Decapoda were caught in the area of the Peru trench at depth 5,740-5,940 m [Menzies, 1964], but it is unknown whether they belonged to benthic or pelagic species.

J. M. Peres [1965] regarding bottom-dwelling shrimp (suborder Natantia) reports that during descent of the Archimede bathyscaphe in the Puerto Rico trench he observed through the porthole shrimp floating above the bottom at depth 7,250 m. Unfortunately, no photographs were taken of these Crustaceans. In the report of R. Hessler et al. [1978], on the photographs of animals collected near bait that was lowered to the floor in four parts of the Chile trench at depths from 6,767 to 7,196 m, among the mass clusters of Amphipoda, Decapoda Natantia were sometimes found. However, only one catch of a bottom-dwelling shrimp was made below 6 km. A born egg of a female Glyphocrangon atlantica Chace (family Glyphocrangonidae) about 12 cm long (Fig. 37) was caught during the 1967 trawling in the western Cayman trench at depth 6,364-6,373 m (J. Elliot Pilsbury, st. 575). This species is known from 4 findings (3 in the Caribbean Sea and 1 in the Bay of Biscay) at depths from 3,885 to 6,373 m [Holthuis, 1971].

The report of J. Piccard [Piccard, Dietz, 1963] that during the descent of the Trieste bathyscaphe in the Mariana trench near the floor at depth 10,900 m a successful observation was made

Figure 37. Bottom-Dwelling Shrimp Glyphocrangon atlantica from the Cayman Trench from Depth 6,373 m [per: Holthuis, 1971]

Figure 38. Mollusk of Subclass Caudofeveata-Chevroderma whitlatchi from the Kuril-Kamchatka Trench from Depth 8,060-8,235 m
View from side (A) and from front (B) (Fig. D. L. Ivanova)

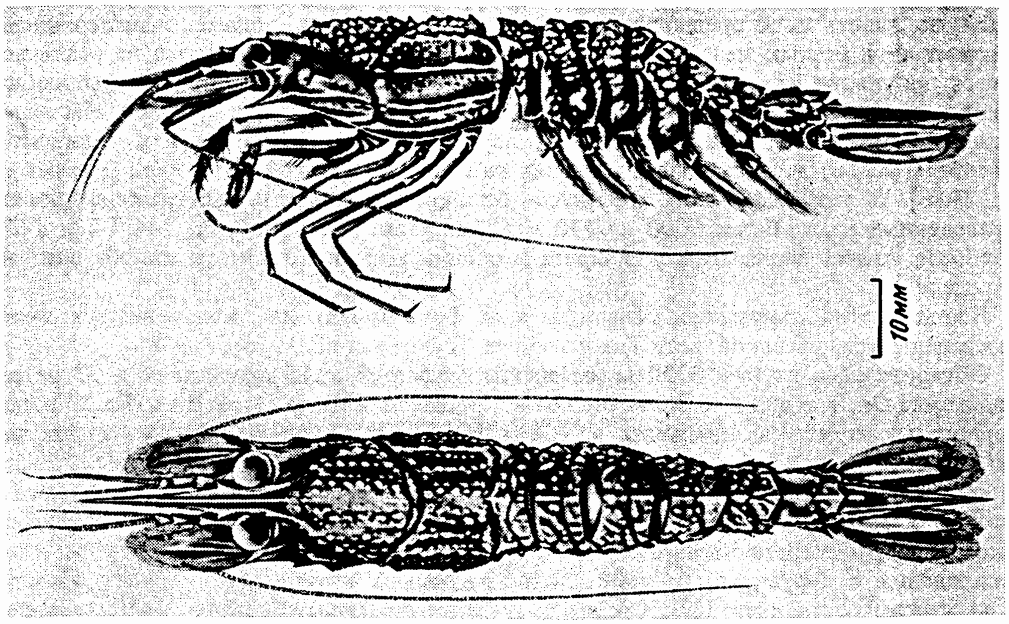

Рис. 37. Придонная креветка Glyphocrangon atlantica из желоба Кайман с глубины 6373 м [по: Holthuis, 1971]

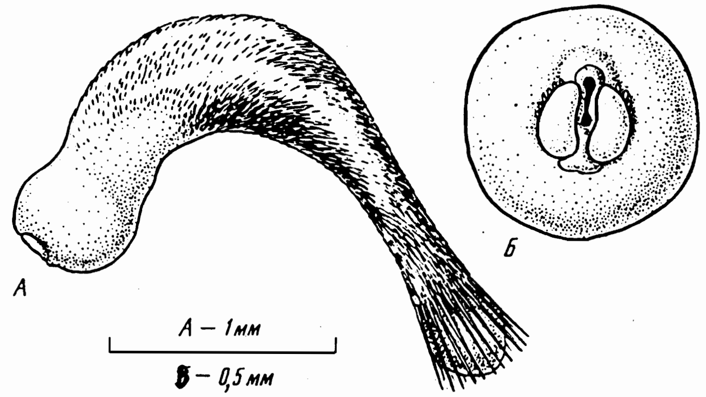

Рис. 38. Моллюск подкласса Caudofoveata – Chevroderma whitlatchi из Курило-Камчатского желоба с глубины 8060–8135 м

Вид сбоку (*А*) и спереди (*Б*) (рис. Д.Л. Иванова)

через иллюминатор "красную креветку", по-видимому, ошибочно. Рачок, которого заметил Пиккар, скорее всего, относится к отряду Mysidacea, представителей которого неоднократно удавалось ловить в желобах, соседних с Марианским, на глубинах почти до 9 км.

КЛЕЩИ – ACARIFORMES

Морские клещи (сем. Halacaridae) еще сравнительно недавно не были известны с абиссальных глубин. Лишь 20 лет тому назад они были найдены в Тихом океане на глубинах около 4000 м [Newell, 1967], а вскоре новый род и вид этого семейства – Bathyhalacarus quadricornis Sokolow et Jankowskaja был описан по двум нахождениям

through the porthole of a "red shrimp" which was apparently erroneous. The shrimp that Piccard noted most likely belonged to the order Mysidacea whose representatives have been repeatedly caught in trenches that neighbor the Mariana at depths almost to 9 km.

ACARIFORMES

Acarina (family Halacaridae) were not known comparatively recently from abyssal depths. They were only found 20 years ago in the Pacific Ocean at depths about 4,000 m [Newell, 1967], and soon a new genus and species of this family, Bathyhalacarus quadricornis Sokolow et Jankowskaya was described from two findings in the region of the Kuril-Kamchatka trench at depths 5,100-5,200 m [Sokolov, Yankovskaya, 1968, 1970]. A representative of this same species was subsequently found even deeper than 6 km, in the Izu-Bonin trench at depth 6,770-6,850 m (Vityaz, st. 7407) [Yankovskaya, 1978].

PANTOPODA

At depths over 6 km, the Pantopoda are rarely encountered and are not found below 7,370 m. Single specimens that belong to 9 species of six genera and three families (Appendix II, Table 15) were found at 13 stations in five Pacific Ocean trenches and in the South Sandwich trench and the Scotia Sea in the Atlantic Ocean. An additionaly two undefined, close specimens of Pantopoda were caught in the Peru trench (Eltanin, st. 37 [Menzies, 1964]).

All the Pantopoda known from depths over 6 km belong to the typically deep-sea species. Three species and one subspecies were not found at lower depths, three species also dwell iin abyssals, and two are widespread from the lower bathyal zone to a depth only slightly over 6 km.

MOLLUSCA

APLACOPHORA

Representatives of both subclasses of Aplacophora have been found below 6 km, but processing of almost all the collected materials has not yet been completed. Single specimens of the family Neomeniidae of the Solenogastres subclass were found in the Kermadec {Galathea, st. 658, 6,660-6,770 m [Wolff, 1960[), Kuril-Kamchatka (Vityaz, st. 3457 and 5616, 6,475-8,015 m) and Yavan (Vityaz, st. 4535, 6,820-6,850 m) trenches.[1]

There were more numerous representatives of the second subclass, Caudofoveata at depths over 6 km that are known in more than 30 findings. The species Chevroderma whitlatchi Scheltema (family Prochaetodermatidae) has been described from the northeast Pacific Ocean [Scheltema, 1985] from depths from 2,730 to 7,298 m (Aleutian trench, Thomas Washington, st. H-39). This same species was found in the Kuril-Kamchatka trench (Vityaz, st. 5615, 8,060-8,135 m) (Fig. 38). Undefined species belonging to the same family of the genus Prochaetoderma s. lato were found in the Aleutian, Kuril-Kamchatka, Japan trenches and Northeast trough of the Pacific Ocean (Vityaz, 13 findings at depths from 6,065 to 8,355 m), Bougainville (Vityaz, 2 findings, 6,920-9,043 m), Peru (Akademik Kurchatov, 3 findings, 6,040-6,240 m) and Yavan (Vityaz, 4 findings, 6,433-7,060 m). The Caudofoveata subclass also includes 2 findings in the Peru trench (Akademik Kurchatov, 6,040-6,240 m), Chaetoderma sp. (family Chaetodermatidae) and one in the Banda trench (Vityaz, 7,130 m), Crystallophrisson sp. (family Crystallophrissonidae).

Aplacophora have additionally been collected and not defined more precisely in the Peru trench by expeditions on the vessels Vema, Eltanin and Anton Bruun at depths 6,002-6,328 m [Menzies et al., 1959; Menzies, 1964; Frankenburg, Menzies, 1968] and Soviet expeditions in the South Sandwich, Hjort trenches and in the Scotia Sea at depths up to 6,150 m [Vinogradova et al., 1974, 1978]. The Aplacophora collected below 6 km thus belong to no less than 5 genera of 5 families, and apparently, no less than 10 species.

Aplacophora representatives (mainly Caudofoveata) are distributed very nonuniformly in the trenches. Thus, for example, they have not been found in almost any of the trenches of the western tropical Pacific Ocean (except for single findings in the Bougainville and Banda trenches), and in the

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[1] All analyses of Aplacophora from the collections of the Soviet expeditions are based on the unpublished data of D. L. Ivanov who processed these collections.

Atlantic Romanche and Puerto Rico trenches. They were also found in all four bottom-grab samples obtained by an expedition on

Figure 39. A Piece of Sunken Wood Raised in the Cayman Trench during
Trawling at Depth 6,740 m (A) on Which Numerous Animals Were Living;
Polychaeta from the Serpulidae family, 39 specimens of chitons Ferreiraella caribbea (B),
13 specimens of starfish Caymanostella spinimarginata (C) and others
[A and B per Wolff, 1979]

Akademik Kurchatov in the Peru trench from depths from 5,960 to 6,240 m and were found three times in this trench by American expeditions. In the trenches of the northern Pacific Ocean, about 90 specimens of Caudofoveata were collected by expeditions on Vityaz in 5 trawling and 7 bottom grab samples, and in a bottom grab sample from depth 7,298 m in the Aleutian trench there were 31 specimens of these Mollusca [Jumars, Hessler, 1976]. In the Yavan trench, 85 specimens were obtained in four of the six samples taken by Vityaz. They were also normal in the Antarctic trenches, and during trawling in the Scotia Sea that covered depths from 5,650 to 6,070 m 84 specimens of these Mollusca were caught. Apparently one of the main factors that determines the dissemination of deep-sea Caudofoveata is the food conditions that are fairly favorable in the eutrophic ocean regions.

LORICATA

Loricata from depths over 6 km are only known from four findings of representatives of the family Leptochionidae, order Lepidopleurida in trenches located in the tropical zone of the Pacific and Atlantic Oceans. From the Bougainville trench from depth 6,920-7,657 m (Vityaz, st. 3655) Leptochiton vitjazi (Sirenko) was described, that was initially indicated under the genus name of Lepidopleurus [Sirenko, 1977, 1988]. Until this time, Loricata were only known from depths to 4,210 m [Clarke, 1962a]. Vityaz expeditions apparently also caught Loricata of the same genus in the New Hebrides trench (st. 3849, 6,680-6,830 m, 1 specimen [Beliaev, 1966b] and in the Palau trench (st. 7291, 7,000-7,170 m, 12 specimens [Beliaev, Mironov, 1977a].

"Академике Курчатове" в Перуанском желобе с глубин от 5960 до 6240 м и были трижды найдены в этом желобе американскими экспедициями. В желобах северной части Тихого океана около 90 экз. Caudofoveata собраны экспедициями на "Витязе" в 5 траловых и 7 дночерпательных пробах, а в дночерпательной пробе с глубины 7298 м в Алеутском желобе оказался 31 экз. этих моллюсков [Jumars, Hessler, 1976]. В Яванском желобе 85 экз. получены в четырех из шести взятых в нем "Витязем" проб. Обычными они оказались и в антарктических желобах, а при тралении в море Скотия, охватившем глубины от 5650 до 6070 м, были пойманы 84 экз. этих моллюсков. По-видимому, один из основных факторов, определяющих распространение глубоководных Caudofoveata, – достаточно благоприятные для них пищевые условия в эвтрофных районах океана.

ПАНЦИРНЫЕ, ИЛИ ХИТОНЫ, – LORICATA

Хитоны с глубин более 6 км известны только по четырем нахождениям представителей сем. Leptochitonidae, отряда Lepidopleurida в желобах, расположенных в тропической зоне Тихого и Атлантического океанов. Из Бугенвильского желоба с глубины 6920–7657 м ("Витязь", ст. 3655) описан Leptochiton vitjazi (Sirenko), первоначально указанный под родовым названием Lepidopleurus [Сиренко, 1977, 1988]. До этого хитоны были известны лишь с глубин до 4210 м [Clarke, 1962a]. Экспедициями на "Витязе" хитоны, по-видимому, того же рода были пойманы также в Ново-Гебридском желобе (ст. 3849, 6680–6830 м, 1 экз. [Беляев, 1966б]) и в желобе Палау (ст. 7291, 7000–7170 м, 12 экз. [Беляев, Миронов, 1977a]).

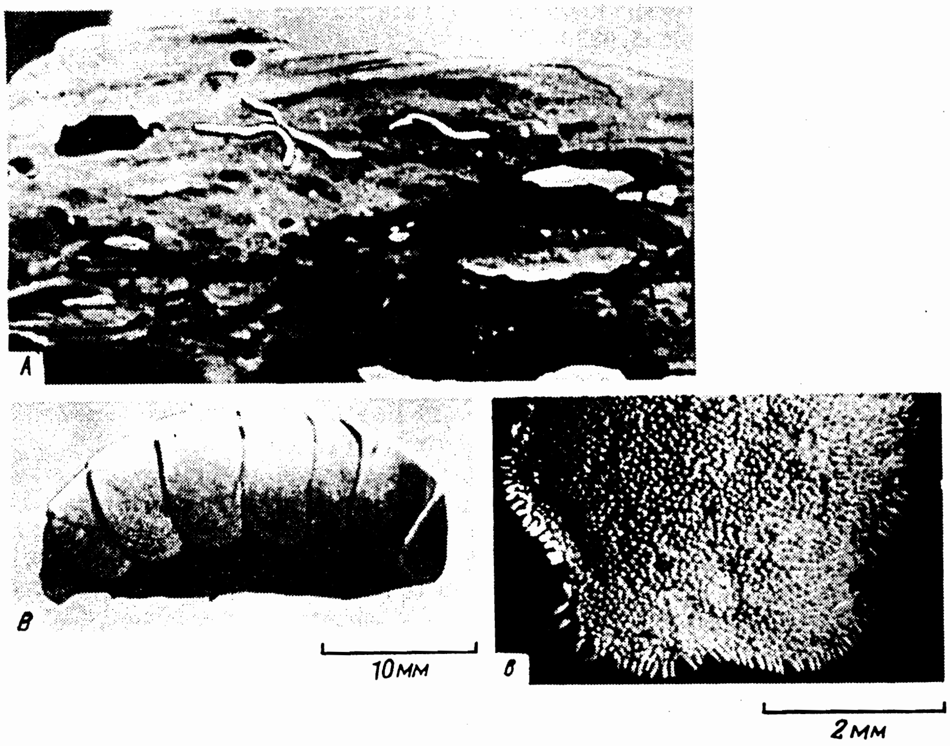

Рис. 39. Часть куска затонувшей древесины, поднятого в желобе Кайман при тралении на глубине 6740 м (*А*), на котором обитали многочисленные животные: полихеты из сем. Serpulidae, 39 экз. хитонов Ferreiraella caribbea (*Б*), 13 экз. морских звезд Caymanostella spinimarginata (*В*) и др. [*А*, *Б* – по: Wolff, 1979]

Yet another finding was made during the work of the research vessel Akademik Kurchatov in the eastern Cayman trench. At st. 1267 from depth 6,740-6,780 a piece of sunken wood was brought up (Fig. 39, A) that was used as a substrate for numerous and diverse animals, among which there were 39 specimens of Loricata. A participant in this expedition, T. Wolff, gives a photograph of one of them (Fig. 39, B) under the name Lepidopleurus sp. A [Wolff, 1979]. B. I. Sirenko [1988], however, described these Loricata as belonging to a new genus and species Ferreiraella caribbea Sirenko. The genus Ferreiraella includes 6 species and is known from the Pacific and Atlantic Oceans, starting from depth 700 m.

MONOPLACOPHORA

The currently known modern Monoplacophora belong to seven species of four families in the order Monoplacophorida that include one genus each, and several more species about which there is insufficient data to establish their precise taxonomic position [Moskalev et al., 1983]. Based on the data of the same authors, only one species is known from a depth somewhat over 200 m, and all the others dwell only below 2,000 m. From depths over 6 km there are 4 known species, of which 3 have been found in the Peru trench, and the fourth to the north of the Hawaiian Islands. Two species from the Peru trench belong to the family Vemidae, Vema bacescui (Menzies) (Anton Bruun, st. 113, 5,986-6,134 m [Menzies, 1968]) and V. ewingi (Clarke et Menzies) (Vema and Eltanin, one finding, Anton Bruun, 4 findings, and Akademik Kurchatov, 2 findings; depths from 6,006 to 6,489 m). V. ewingi dwells in the area of the Peru trench and in the lower abyssal zone, starting from depth 5,300 m [Clarke, Menzies, 1959; Menzies et al., 1959; Menzies, 1963, 1968; Zenkevitch, Filatova, 1971; Moskalev et al., 1983].

In addition, yet another species was noted in the Peru trench indicated under the name Neopilina sp. indet. (Anton Bruun, 2 findings, 6,146-6,354 m [Menzies, 1968]). From the northeast Pacific Ocean trough (Thomas Washington, st. H-30, 6,065-6,079 m) a species Neopilina oligotropha has been described [Rokor, 1972], but Moskalev et al. [1983] believe that this species may be included not only in the genus Neopilina, but also in the family Neopilinidae.

GASTROPODA

Gastropod mollusks have been found in all the studied trenches and troughs (over 120 findings in trawling catches) at all depths to 9,995-10,015 m in the Kermadec trench. Judging f rom the finding at depth 10,415-10,687 m in the Tonga trench of their small empty shells that do not dissolve [Beliaev et al., 1960] it may by hypothesized that they also dwell at this depth. At an even greater depth (10,700-10,730 m) in the Mariana trench remains were also found of several small Gastropoda shells, but they only had a preserved periostracum while the calcareous part was dissolved [Beliaev, Mironov, 1977a].

Of the Gastropoda found below 6 km, species definitions are known for 56 species from 35 genera (the descriptions of some of them have not yet been published), but many data have not yet been processed or have only been defined to the genus or family. Apparently, after a complete evaluation of the already collected materials, the number of known Gastropoda species from depths over 6 km will be close to 100. However, in the majority of cases, these mollusks are encountered in samples in only a small number. The composition of the ultra-abyssal Gastropoda is very variegated; there are known representatives of all four subclasses, 10 orders, 20 families and at least 41 species (Appendix II, Table 16). But some groups clearly dominate in diversity and frequency of encounter over the others. For example, the family Turridae is represented by 19 Pacific Ocean species (including 1 subspecies) and 31 findings are known below 6 km; family Bussinidae, no less than 11 species from

Figure 40. Vertical Dissemination of Gastropoda Known from Depths over 6 km (A), and Change with Depth in Number of Species (1) and Percentage of Endemism (2) (B)

17 locations in Pacific Ocean trenches, and family Cocculinidae, also 11 species from 14 locations in all three oceans, but mainly in the Atlantic.

Figure 40 shows the vertical dissemination of the hadal Gastropoda. Endemism at the species level is 68%, but in the majority of cases the endemic species are only known from a single finding. As in the majority of other groups, the number of species diminishes with depth, while the percentage of endemism rises. Of the species that are not endemic for the trenches, two-thirds do not rise above the abyssal depths. There was unusually high endemism in this group on the genus level. Of the 55 genera for which there are species analyses, 9 (26%) were endemic for the ultra-abyssal (see Table 10), and another 4 (Bandabyssia Moskalev, Oenopotella Sysoev, Tacita Lus and Trenchia Knudsen) are disseminated only in the trenches and their adjoining regions of the ocean floor at depths less than 5-5.5 km.

SCAPHOPODA

Mollusks of the Scaphopoda class are known from depths over 6 km from 20 findings (of them, 19 from Soviet expedition collections). They were found in the Pacific Ocean, in trenches and troughs of its northern section and in the Bougainville trench, in the Indian Ocean in the Yavan trench, and in the Atlantic in the Cayman, Romanche, South Sandwich trenches and the Scotia Sea (Appendix II, Table 17). Species analyses are only known for three species (one with two subspecies). The Soviet expedition collections were evaluated by the late C. D. Chistikov, but unfortunately, most of the collection remains unevaluated or defined only to the family. Of the four species and subspecies, one is known only from depth about 7 km, and the other three, in the range from 4,370 to 6,780 m. The greatest depth of finding Scaphopoda is 6,920-7,657 m in the Bougainville trench. All the other ultra-abyssal findings are confined to depths less than 7 km.

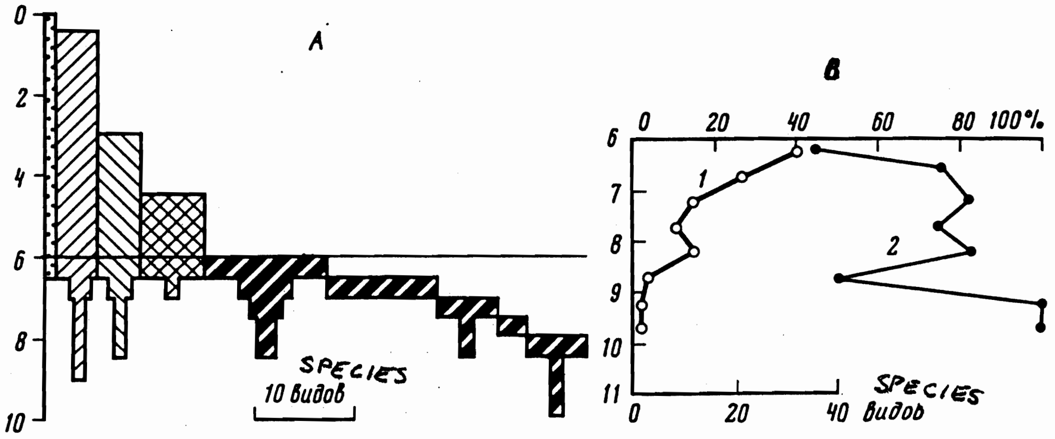

Рис. 40. Вертикальное распространение Gastropoda, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

17 местонахождений в желобах Тихого океана, а сем. Cocculinidae – также 11 видами из 14 местонахождений во всех трех океанах, но главным образом в Атлантическом.

На рис. 40 показано вертикальное распространение хадальных гастропод. Эндемизм на видовом уровне составляет 68%, но в большинстве случаев эндемичные виды известны лишь по единственному нахождению. Как и в большинстве других групп, число видов с глубиной уменьшается, а процент эндемиков возрастает. Из видов, не эндемичных для желобов, две трети не поднимаются выше абиссальных глубин. Необычно высок оказался в этой группе эндемизм на родовом уровне. Из 35 родов, для которых есть видовые определения, 9 (26%) эндемичны для ультраабиссали (см. табл. 10), а еще 4 (Bandabyssia Moskalev, Oenopotella Sysoev, Tacita Lus и Trenchia Knudsen) распространены только в желобах и прилегающих к ним районах ложа океана на глубинах не менее 5–5,5 км.

ЛОПАТОНОГИЕ – SCAPHOPODA

Моллюски класса Scaphopoda известны с глубин более 6 км по 20 нахождениям (из них 19 по сборам советских экспедиций). Они найдены в Тихом океане – в желобах и котловинах его северной части и в Бугенвильском желобе, в Индийском – в Яванском желобе и в Атлантическом – в желобах Кайман, Романш, Южно-Сандвичев и в море Скотия (Приложение II, табл. 17). Видовые определения пока известны лишь для трех видов (один – с двумя подвидами). Обработка сборов советских экспедиций проводилась покойным С.Д. Чистиковым, но, к сожалению, бóльшая часть сборов осталась необработанной или определенной лишь до семейства. Из четырех видов и подвидов один известен только с глубины около 7 км, а три остальные – в пределах диапазона от 4370 до 6780 м. Наибольшая глубина нахождения скафопод – 6920–7657 м в Бугенвильском желобе. Все остальные ультраабиссальные нахождения приурочены к глубинам менее 7 км.

ДВУСТВОРЧАТЫЕ – BIVALVIA

Двустворчатые моллюски, обитающие в глубоководных желобах, не менее разнообразны, чем брюхоногие, но в отличие от последних нередко образуют массовые популяции. По средней численности в траловых уловах, полученных с глубин более 6 км, они занимают второе место после голотурий (см. рис. 55). Они встречены во всех обследованных желобах и на всех глубинах вплоть до глубин более 10,5 км в желобах Марианском и Тонга. Частота встречаемости по траловым уловам составляет более

BIVALVIA

Bivalve mollusks that dwell in the deep-sea trenches are no less diverse than the Gastropoda, but in contrast to the latter, they often form mass populations. They are in second place after the Holothurioidea (see Fig. 55) in average numbers in the trawling catches from depths over 6 km. They are encountered in all the studied trenches and at all depths all the way to over 10.5 km in the Mariana and Tonga trenches. The frequency of encounter in the trawling catches is over

TABLE 5. MASS FINDINGS OF BIVALVE MOLLUSKS IN SOME TRAWLING CATCHES BY VITYAZ EXPEDITIONS FROM DEPTHS OVER 6,000 m

Key:
1. No. of station
2. Depth, m
3. Total number of caught animals, species/specimens
4. Total number of species/specimens
5. % of all caught animals, species/specimens
6. Species
7. Number of specimens of this species

82%, and they are generally missing only in unrepresentative catches. Species analyses are now known for 47 species. Additionally, many data that have not yet been completely evaluated refer to over 20 taxons only defined to the genus or family, and apparently, include several more dozen species. The available analyses refer to 33 taxons of genus level, 14 families and 6 orders (Appendix II, Table 18). The greatest number of genera and species is represented by the family Ledellidae which includes 19

Таблица 5

Массовые нахождения двустворчатых моллюсков в некоторых траловых уловах, полученных экспедициями на "Витязе" с глубин более 6000 м

№ станции 1	Глубина, м 2	Общее число пойманных животных, виды/экз. 3	Bivalvia			
			Общее число, виды/экз. 4	% от всех пойманных животных, виды/экз. 5	Вид 6	Число экз. данного вида 7
			Курило-Камчатский желоб 8			
2208	7210–7230	52/780	4/390	8/50	Bathyspinula vitjazi	184
					Tindaria sp.	189
5611	7600–7710	16/290	4/230	25/79	Parayoldiella mediana	227
5612	8185–8400	33/5243	6/3500	18/67	Vesicomya sergeevi	3496
5632	8240–8345	20/280	3/210	15/75	V.profundi	119
5631	9070–9345	15/8400	3/205	20/2	V.sergeevi	186
5627	9170–9335	12/3800	3/640	25/17	Yoldiella ultraabyssalis	440
					Vesicomya sergeevi	191
5628	9520–9530	12/20000	2/5315	17/27	Yoldiella ultraabyssalis	3380
					Vesicomya sergeevi	1935
			Японский желоб 9			
6151	7370	33/3600	5/3500	15/97	Vesicomya sp.	3300
					Parayoldiella mediana	186
7500	7350–7370	30/1550	5/1217	17/79	Axinulus sp.	757
					Spinula bogorovi	173
					Parayoldiella mediana	189
3571	7565–7587	35/1640	7/982	20/60	Axinulus sp.	632
					Malletia sp.	260
			Желоб Кермадек 10			
3827	8928–9174	20/320	3/271	15/85	Vesicomya bruuni	191
3831	9995–10015	10/150	2/126	20/84	Axinulus sp.	124
			11 Яванский желоб			
4535	6820–6850	28/715	4/546	14/76	Vesicomya sundensis	530
4530	6935–7060	8/515	1/483	12/94	Axinulus sp.n. Filatova	483

82%, причем отсутствуют они, как правило, лишь в малопредставительных уловах. Видовые определения известны пока для 47 видов. Кроме того, многие материалы, обработка которых еще не завершена, относятся к более чем 20 таксонам, определенным лишь до рода или до семейства, и, видимо, включают еще несколько десятков видов. Имеющиеся определения относятся к 33 таксонам родового ранга, к 14 семействам и 6 отрядам (Приложение II, табл. 18). Наибольшим числом родов и видов представлено сем. Ledellidae, к которому относятся 19 видов из 5 родов и, видимо, еще несколько видов включают пока не обработанные материалы. Ультраабиссальная фауна каждого из остальных 13 семейств значительно менее разнообразна.

Нередко в траловых уловах, особенно с глубин примерно от 7 км и более, двустворчатые моллюски могут быть очень многочисленными и доминировать над остальными животными. Некоторые примеры таких массовых нахождений приведены в табл. 5. В среднем для 12 траловых уловов, полученных с глубин от 7 до 8 км из Алеутского, Курило-Камчатского и Японского желобов, двустворчатые моллюски составляли 41% по численности и 17% по числу видов от всех пойманных животных. Для 9 уловов, полученных в Курило-Камчатском желобе с глубин от 8 до 9 км, они составляли по численности 24%, и даже на глубинах 9000–9600 м, на которых в этом желобе господству-

species from 5 genera, and apparently, the unprocessed materials include several more species. The ultra-abyssal fauna of each of the remaining 13 families is considerably less diverse.

Bivalve mollusks may often be very numerous and dominate over the other animals in the trawling catches, especially from depths approximately from 7 km and more. Some examples of these mass findings are given in Table 5. On the average, for the 12 trawling catches from depths 7 to 8 km from the Aleutian, Kuril-Kamchatka and Japan trenches, bivalve mollusks comprised 41% in number and 17% in number of species of all the animals caught. For 9 hauls in the Kuril-Kamchatka trench from depths 8 to 9 km, they comprised 24% in number, and even at depths 9,000-9,600 m at which there is a dominance in this trench

Figure 41. Vertical Dissemination of Bivalvia Known from Depths over 6 km (A), and Change with Depth in Number of Species (1) and Percentage of Endemics (2) (B)

of extremely numerous Holothurioidea, Bivalvia still averaged 8% in number.

Of the 47 known species, 32 have not been encountered at depths less than 6 km. Endemism at the species level is thus 68%. Endemic species are generally confined either to some one trench, or to two or several adjoining trenches. Of the species that are also known from lower depths, 9 do not rise beyond the abyssal and 6 are eurybathic. Of the latter, 3 are species borer-mollusks from the family Teredinidae and Pholadidae that were found by the Galathea expedition in sunken Pandanus brought up in the Banda trench at one station from depths somewhat over 7 km. Both types of Teredinidae were previously known only from shoals [Turner, 1966], and the new species Xylophaga grevei described by J. Knudsen, except for the Banda trench, are also known from two findings in the seas of the Indian-Malaysian archipelago from considerably lower bathyal depths. Although adults of these mollusks could exist in the trench depths, it is not known if they are capable of reproducing there. Knudsen [1970] classifies them as so-called "guest" species whose populations could be maintained in the trenches only by replacement from the higher deep-sea habitats where these species normally live and reproduce. There are well-known, similar sterile species of the migration area lying beyong the main range and reproduction area [Ekman, 1953; Parin, 1968; Beklemishev, 1969] for many plankton organisms and pelagic fish in both a horizontal and vertical direction of their dissemination, and among the benthic animals, e.g., for the Asterias rubens in very fresh water areas of the Baltic Sea [Bock, Schlieper, 1953].

There is only one endemic genus for the ultra-abyssal zone, Paryoldiella Filatova, 1971, that includes two subgenera, (Intercalaria Filatova et Schileiko, 1984 and Parayoldiella s. str. Filatova, 1971) and 8 species, as well as the suborder Polycordia (Angustebranchia) V. Ivanova, 1977 that includes 6 species. Apparently, another two genera are also endemic from the familiy Nuculanidae as defined by the late Z. A. Filatova as new and undescribed. Mollusks of one of them were found at depths over 9 km in the Tonga and Kermadec trenches [Beliaev et al., 1960], and another in the Yavan trench at depth about 7 km [Filatova, 1961].

The vertical distribution of the ultra-abyssal Bivalvia is shown in Fig. 41. It is apparent from Fig. 41, B that the fauna at level 6-6.5 km has a clearly pronounced transient nature; the species endemism in this level is only about 10%, and it rapidly rises as the depth increases.

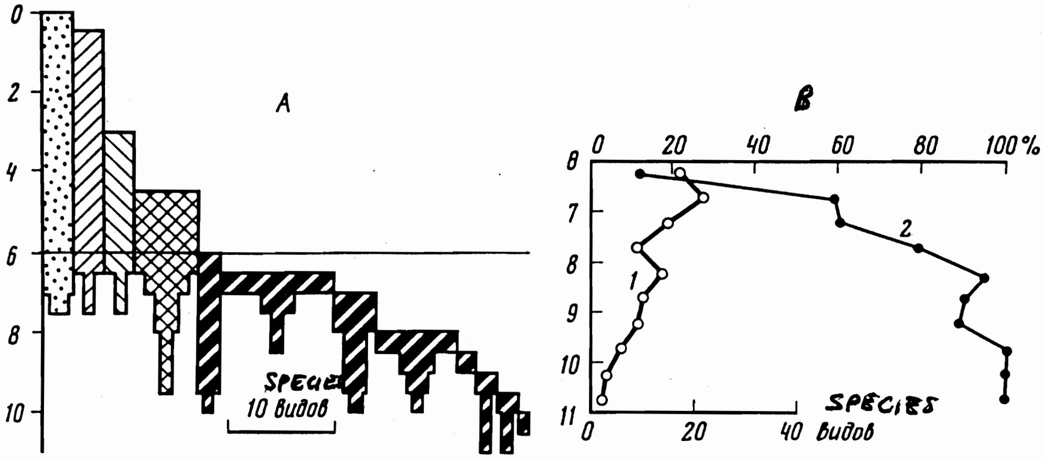

Рис. 41. Вертикальное распространение Bivalvia, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

ют чрезвычайно многочисленные голотурии, Bivalvia все же составляли в среднем 8% по численности.

Из 47 известных видов 32 не встречены на глубинах менее 6 км. Таким образом, эндемизм на видовом уровне составляет 68%. Как правило, эндемичные виды приурочены либо к какому-либо одному желобу, либо к двум или нескольким смежным желобам. Из видов, известных и с меньших глубин, 9 не поднимаются за пределы абиссали и 6 эврибатные. Из числа последних 3 вида – моллюски-древоточцы из семейств Teredinidae и Pholadidae, обнаруженные экспедицией на "Галатее" в затонувших плодах пандануса, поднятых в желобе Банда на одной станции с глубины несколько более 7 км. Оба вида терединид ранее были известны лишь с мелководий [Turner, 1966], а описанный Й. Кнудсеном новый вид Xylophaga grevei, кроме желоба Банда, известен еще по двум нахождениям в морях Индо-Малайского архипелага со значительно меньших батиальных глубин. Хотя взрослые особи этих моллюсков могут существовать в глубинах желобов, но неизвестно, способны ли они там размножаться. Кнудсен [Knudsen, 1970] относит их к так называемым "гостевым" видам, популяции которых могут поддерживаться в желобах только за счет пополнения из менее глубоководных местообитаний, где эти виды нормально живут и размножаются. Подобные же лежащие за пределами основного ареала и области размножения вида стерильные области выселения [Ekman, 1953; Парин, 1968; Беклемишев, 1969] хорошо известны для многих планктонных организмов и пелагических рыб в направлении как горизонтального, так и вертикального их распространения, а среди донных животных, например для морской звезды Asterias rubens, – в сильно опресненных районах Балтийского моря [Bock, Schlieper, 1953].

Из родов эндемичен для ультраабиссали только один – Parayoldiella Filatova, 1971, включающий два подрода (Intercalaria Filatova et Schileiko, 1984, и Parayoldiella s.str. Filatova, 1971) и 8 видов, а также подрод Polycordia (Angustebranchia) V. Ivanova, 1977, включающий 6 видов. Кроме того, видимо, эндемичны еще два рода из сем. Nuculanidae, определенные покойной З.А. Филатовой как новые, но оставшиеся неописанными. Моллюски одного из них найдены на глубинах более 9 км в желобах Тонга и Кермадек [Беляев и др., 1960], другого – в Яванском желобе на глубине около 7 км [Филатова, 1961].

Вертикальное распределение ультраабиссальных Bivalvia показано на рис. 41. Из рис. 41, *Б* видно, что фауна горизонта 6–6,5 км имеет ярко выраженный переходный характер – видовой эндемизм в этом горизонте составляет лишь около 10%, а по мере увеличения глубины быстро возрастает.

CEPHALOPODA

Cephalopoda mollusks are not characteristic for trench depths, and apparently only a very few of them are capable of dwelling below 6,000 m. In 1949 in the Kuril-Kamchatka trench at depth 8,100 m an octopus was found [Uschakov, 1952] that apparently belongs to the genus Octopus [Akimushkin, 1963]. The finding of an octopus egg sheath from the subfamily Bathypolypodinae in the intestine of the fish Careproctus ambylstomposis caught in the Kuril-Kamchatka trench at depth 7,210-7,230 m [Birstein, Vinogradov, 1955a] is also an indication of the existence of octopi in the ultra-abyssal zone. Octopi of this subfamily attach their eggs on the bottom, and probably, the egg was swallowed by this bottom-dwelling fish at approximately the same depth at which it was caught [Akimushkin, 1963]. Finally, a report was published in 1977 [Voss et al., 1977] about a 1975 catch by the American J. E. Pilsbury expedition in the western Cayman trench (Bartlett basin) at depth 7,280 m of the octopus Grimpotheuthis sp. (family Cirrotheuthidae). Octopi of this family usually lead a bottom-dwelling lifestyle. Several abyssal species, including from the Atlantic Ocean [Hesis, 1982] were already known in the genus Grimpotheuthis.

SIPUNCULA

The collections of Spinucula from the deep-sea trenches have been almost completely evaluated [Murina, 1957-1974]. The greatest known depth of Sipuncula finding is 7,000 m in the Chile trench; during trawling at this depth 1 specimen of Golfingia schuttei was caught. The only specimen close to Sipuncula that has not yet been defined was in a bottom-drag sample obtained in the Aleutian trench from an even greater depth, 7,298 m [Jumars, Hessler, 1976]. There are 8 known species of the genera Golfingia and Phascolion (Appendix II, Table 19) from depths 6 to 7 km. Only one species, Golfinia sectile, described by a single specimen found in the South Sandwich trench at depth about 6,100 m, is not known from lower depths. The remaining 7 species are eurybathic and are disseminated in a broad depth range, from the sub-littoral or bathyal zone to over 6 km. The majority of Sipuncula findings below 6 km are confined to the trenches and troughs of the northern Pacific Ocean. Here (Aleutian, Kuril-Kamchatka, Japan trenches and Northeast trough) the frequency of encounter of Sipuncula in the trawling hauls from depth 6 to 7 km was 62% (13 of 21 successful trawlings). At 4 stations (Vityaz, st. 2144, 3214, 3363 and 4074, see Appendix I) there were masses of Sipuncula; there were two or three species in each of the trawling hauls at the aforementioned stations, and they numbered from 160 to 615 specimens, respectively from 32 to 46% of all the animals caught. Phascolion lutense was this mass form in three instances, and in one instance, Golfingia minuta. Sipuncula were found in the other ocean regions in the Peru, Chile, Yavan and South Sandwich trenches, and in the Scotia Sea trough, but there were few of them in these regions and most often only single specimens.

V. V. Murina [1969] notes that among the 15 Sipuncula genera, there is not a single exclusively deep-sea genus or suborder, which indicates the comparatively recent settlement of the great depths by representatives of this group that should be considered typically secondary deep-sea dwellers, per the terminology of A. P. Andriashev [1953].

BRYOZOA

The Galathea expedition found Bryozoa of the genus Bugula in the Kermadec trench during trawling at depth 8,210-8,300 m [Bruun, 1963b; Wolff, 1960]. Bryozoa (for the most part only small fragments of colonies) were also found by Vityaz in the Yavan at depth 6,487 m [Beliaev, Vinogradova, 1961a], Kurila-Kamchatka (5 stations from 6,090 to 8,400 m), Izu-Bonin (8,800-8,830 m) and North east basin of the Pacific Ocean trenches (6,065 m) and by Akademik Kurchatov in the Romanche (7,340 m) [Pasternak, 1968] and Chile trenches (7,000 m). None of these collections have been processed. The greatest depth of finding of whole colonies is 8,185-8,400 m in the Kuril-Kamchatka trench. Among the Bryozoa collected in this trench, some probably belong to the genus Kinetoskias which like the Bugula are included in the family Bicellariidae. Two species of Kinetoskias are also known from the abyssal zone near the Kuril-Kamchatka trench of the Okhotsk and Bering Seas [Klyuge, 1962]. Fourteen dendritic colonies of yet undefined close Bryozoa were also obtained during trawling in the Scotia Sea that were caught at depths from 5,650 to 6,070 m [Vinogradova et al., 1974].

According to the calculations of T Schopf [1969] who summarized the data of the majority of the deep-sea expeditions, the frequency of encounter of Bryozoa in various abyssal levels fluctuated from 20 to 30%. Bryozoa are less characteristic for trench depths, their frequency was less than 10% in traps from depths over 6 km.

All the Bryozoa that dwell below 3,000 m belong to the order Cheilostomata [per: Silen, 1951]; It is likely that the Bryozoa found iin the trenches only belong to this order.

BRACHIOPODA

The deepest sea species of Brachiopoda, Pelagodiscus atlanticus (King) (family Discinidae from the class of Inarticulata) are widespread in the bathyal and abyssal depths at the bottom of the World Ocean. The greatest known depth of occurrence of live specimens is 5,530 m in the northern Pacific Ocean. Empty shell cusps of this species were found even deeper in the Pacific Ocean, at depths to 5,800 m and in one instance, in the northwest trough at depth 6,160 m [Zezina, 1965, 1970], and in the Atlantic Ocean in the Romanche trenche even at depth 7,460-7,600 m [Zezina, 1985]. No live Brachiopoda have ever been found in the collections from the deep-sea trenches. However, in the New Hebrides trench, small flattened specimens of Articulata Brachiopoda were photographed at depth 6,758-6,776 m [Lemche et al., 1976]. O. N. Zezina [1985] hypothesizes that these Brachiopoda belong to the family Phaneroporidae that she isolated and representatives of which are known from the abyssal Atlantic and Indian Oceans.

CHAETOGNATHA

M. Ye. Vinogradov [1968, 1970a] indicates that single, small Chaetognatha Eukrohnia fowleri Ritter-Zahoni were found in the Kuril-Kamchatka trench during catches by closing plankton nets of levels 7,000-6,000 and even 8,700-7,000 m. According to A. P. Kassatkina [1982], this species includes 2 subspecies. The typical subspecies found iin the northern Pacific Ocean dwells below 100 m, and the shallower and deep-sea form that dwells at depths over 1,000 m in the "northern seas" (p. 62) are classified by Kassatkina as a special subspecies E. fowleri leviset Kassatkina. It may be assumed that the Chaetognatha found below 6,000 m belong either to the latter subspecies, or to a new, not yet described form. J. M. Peres [1965] mentions a white Chaetognatha that he noted from the Archimede bathyscaphe at depth over 6,000 m in the Puerto Rico trench.

ECHINODERMATA

CRINOIDEA

The columnar Crinoidea of the genus Bathycrinus (family Bathycrinidae) are represented by approximately eight new species in the Vityaz collections from the Aleutian, Kuril-Kamchatka, Japan and Izu-Bonin trenches and from the northern troughs of the Pacific Ocean at 16 stations at depths from 6,065 to 9,735 m based on preliminary analyses [Beliaev, 1966b, 1972; Belyaev, 1972]. None of these species has been found at depths less than 6 km. One of them, dwelling in the Kuril-Kamchatka trench at depths 8,175-9,345 m was massive. It was found at five stations, and in one case there were 255 specimens in trawling catch, and in another over 100 specimens were collected from one-third of the silt brought up by the trawl (st. 5612 and 2217). Single specimens or only fragments of apparently this same species were also found in the Volcano trenches (2 stations 6,700-8540 m), Palau (2 stations, 7,000-8,035 m) [Beliaev, Mironov, 1977a] and Bougainville (about 8,000 m, fragment [Birstein, Sokolova, 1960]). The Galathea expedition obtained 4 specimens defined by T. Gislen [1956] as B. australis (A. H. Clark) in the Kermadec trench from depth 8,210-8,300 m. This species was previously known in the Antarctic bathyal and abyssal depths. Columnar Crinoidea of apparently the same species were found somewhat below 6 km in the Peru trench on the Vema and Eltanin expeditions [Menzies et al., 1959; Menzies, 1963] and Akademik Kurchatov (depths from 6,006 to 6,328 m), as well as the Vityaz expedition in the Yavan trench at depths 6,935-7,060 and 6,433 m [Beliaev, Vinogradova, 1961a; Beliaev, 1966b]

Representatives of the genus Bathycrinus were found in the Atlantic Ocean in two of five trawling catches from the South Sandwich trench (Akademik Kurchatov, st. 864 and 895, from 6,766 to 7,200 m; in the second catch there were about 60 specimens). They were also found in the Scotia Sea (haul from depth 5,650-6,070 m) [Vinogradova et al., 1974]. The greatest depth at which columnar Crinoidea were caught is 9,715-9,735 m in the Izu-Bonin trench.

Underwater photographs of Bathycrinus were first taken in the Peru trench slightly below 6 km [Menzies, 1963] and in the Palau and New Hebrides trenches at depths 8,021-8,042 and 6,758-6,776 m. Bathycrinus were found in the next trench on no less than 25 photographs, sometimes in groups from 3 to 6 specimens. The mean density of their populations was about 1 specimen per 100 m^2 [Lemche et al., 1976].

Based on the collections of the Soviet expeditions, the frequency of encounter of columnar Crinoidea in the trawling hauls from depths from 6 to 10 km is 22%. Judging from the preliminary analyses, there is a high species endemism (about 90%) to the trench dwellers that belong to this group. It should, however, be stated that the Bathycrinidate family of the columnar Crinoidea need a taxonomic revision and review of the taxonomic signficance of the morphological signs, since they have very great variability in a number of signs that are not only considered specific, but also generic. Three of the smallest non-columnar Crinoidea (family Antedonidae) were found by Vityaz in the Japan trench (st. 3214 and 3593, 6156-6380 m).

ASTEROIDEA

Asteroidea have been found below 6 km in 15 trenches and several troughs of all three oceans all the way to depth 10 km (Appendix II, Table 20). The frequency of encounter in the trawling hauls for depths from 6 to 10 km averaged 42%. However, they are common in the upper ultra-abyssal depths.

Level, km	Number of catches	Rate of incidence, %	Level, km	Number of catches	Rate of incidence, %
6-6.5	29	66	7.5-8	11	36
6.5-7	31	52	8-9	21	19
7-7.5	24	42	9-10	12	8

There is only a single finding of the genus Hymenaster (family Pterasteridae) below 9 km in the Philippine trench at depth about 10 km [Beliaev, Mironov, 1977a]. Representatives of this genus (and possibly, other close genera) are known from depths over 6 km from 23 findings, but only one species, H.

glegvadi has been defined, that is endemic to the Kermadec trench [Madsen, 1956b]; specimens from 22 stations from Soviet expedition stations have not yet been processed. These Asteroida have been found

Figure 42. Photographs of Asteroidea Found in Trenches

Key: a-c--Asteroida of the order Brisingida from the New Hebrides, 8,260 m (a) and Bougainville, 7,847-8,662 m (b, c) Trenches; d, e--Asteroidea of the family Pterastidea, apparently from the genus Hymenaster, Palau Trench, 8.021-8,042 m [per Lemche et al., 1976]

also on photographs of the floor in the New Hebrides and Palau trenches [Lemche et al., 1976] (Fig. 42, D, E).

Of the other Asteroidea, the most common in the trenches are representatives of the families Porcellanasteridae (order Paxillosida) and Freyellidae (Brisingida). Freyellidae, belonging to three species, are represented in collections from depths only to 6,860 m. But these Asteroidea on the bottom photographs probably belong to the three species that were repeatedly observed in the New Hebrides, New Britain and Bougainville trenches (Fig. 42, A-C), including in the last at depth 7,847-8,662 m [Lemche et al., 1976].

The greatest number of species belongs to the family Procellanasteridae, 8 species of 6 genera. The Porcellanasteridae that comprise a special suborder Cribellosa are primarily abyssal Asteroidea that are not known from depths less than 900 m; in the terminology of A. P. Andriyashev they should be considered a primary deep-sea taxon, i.e., one that was formed in the ocean depths, most likely in the abyssal, insofar as the greatest species diversity of these Asteroidea is confined to depths 4-5 km [Beliaev, 1974a]. Probable stages of the ultra-abyssal depths of this population are traced well in the example of the Asteroidea of this family. The genus Eremicaster includes 3 species, E. pacificus, an Indian Pacific Ocean species disseminated predominantly at depths from 1,570 to 3,500 m, but known from depths over 4,088 m. The second, also Indian-Pacific Ocean species E. crassus, is a deeper sea version; it is predominant at depths from 3 to 6 km, where mass populations are often formed, and only two findings (of the 65 known) are confined to depths 6,000-6,328 m (in both cases only 1 specimen was found). Depths 6,000-6,300 m represent the lower boundary of the geographic range of this species. The third species, E. vicinus, is known from 35 findings from depths from 3,949 to 7,246 m; in this case, 22 findings occur at depth over 6 km at which it was found in 8 trenches; precisely at depths over 6 km this species has an inherent and greatest population, in some trawling hauls from the trenches there were dozens of specimens (maximum to 160 specimens), and the average number per one catch below 6 km was double that at lower depths, 24 and 12 specimens [Beliaev, 1985b]. Thus, even now most of the geographic range of this species where it is represented by the greatest mass population occurs in deep-sea trenches, and quite probably, populations from the very isolated trenches could then be isolated and the subsequent evolution will go towards the formation in separated trenches of independent species taxons.

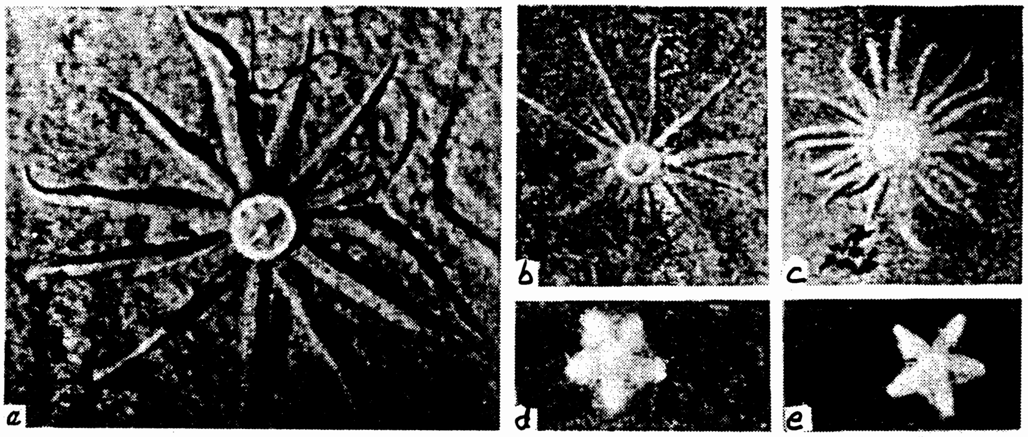

Рис. 42. Фотографии морских звезд, полученные в желобах

а–в — звезды отряда Brisingida из Ново-Британского, 8260 м (*а*), и Бугенвильского, 7847–8662 м (*б, в*) желобов; *г, д* — звезды сем. Pterasteridae, видимо из рода Hymenaster, желоб Палау, 8021–8042 м [по: Lemche et al., 1976]

также на фотографиях дна, полученных в желобах Ново-Гебридском и Палау [Lemche et al., 1976] (рис. 42, *Г, Д*).

Из других морских звезд наиболее обычны в желобах представители семейств Porcellanasteridae (отряд Paxillosida) и Freyellidae (Brisingida). Фрейеллиды, относящиеся к трем видам, представлены в сборах с глубин лишь до 6860 м. Но на фотографиях дна эти звезды, вероятно относящиеся к трем видам, неоднократно удалось наблюдать в желобах Ново-Гебридском, Ново-Британском и Бугенвильском (рис. 42, *А–В*), в том числе в последнем на глубине 7847–8662 м [Lemche et al., 1976].

Наибольшее число видов относится к сем. Porcellanasteridae — 8 видов из 6 родов. Порцелланастериды, составляющие особый подотряд Cribellosa, — преимущественно абиссальные звезды, неизвестные с глубин менее 900 м; по терминологии А.П. Андрияшева, их следует считать первичноглубоководным таксоном, т.е. таким, формирование которого происходило в глубинах океана, вероятнее всего в абиссали, поскольку наибольшее видовое разнообразие этих звезд приурочено к глубинам 4–5 км [Беляев, 1974а]. На примере звезд этого семейства хорошо прослеживаются вероятные этапы заселения ими ультраабиссальных глубин. Так, род Eremicaster включает 3 вида. E. pacificus — индо-тихоокеанский вид, распространенный преимущественно на глубинах от 1570 до 3500 м, но неизвестный с глубин более 4088 м. Второй, также индо-тихоокеанский, вид E. crassus — более глубоководный; он распространен преимущественно на глубинах от 3 до 6 км, где нередко образует массовые популяции, и лишь два нахождения (из 65 известных) приурочены к глубинам 6000–6328 м (в обоих случаях поймано лишь по 1 экземпляру). Глубины 6000–6300 м представляют собой нижнюю границу ареала этого вида. Третий вид — E. vicinus известен по 35 нахождениям с глубин от 3949 до 7246 м; при этом 22 нахождения приходятся на глубины более 6 км, на которых он встречен в 8 желобах; именно на глубинах более 6 км этому виду свойственна и наибольшая численность — в некоторых траловых уловах из желобов она составляет десятки экземпляров (максимально — до 160 экз.), а средняя численность на один улов глубже 6 км вдвое выше, чем на меньших глубинах, — 24 и 12 экз. [Беляев, 1985б]. Таким образом, уже сейчас основная часть ареала этого вида, где он представлен наиболее массовыми популяциями, приходится на глубоководные желоба и, вполне вероятно, в дальнейшем популяции из далеко разобщенных желобов могут оказаться изолированными и последующая эволюция пойдет в направлении формирования в разобщенных желобах самостоятельных таксонов видового ранга. Как бы продолжение

We see continuation of this process in the example of other representatives of ultra-abyssal Porcellanasteridae. In the Cayman trench at depth over 6.5 km there is a mass population of a new Styracaster species, in the chain of trenches stretching along the eastern edge of the Philippine Sea (Volcano, Yap, Palau trenches) the species Porcellanaster ivanovi endemic for them is widespread and penetrates to depth over 8.5 km, and in the neighboring Ryukyu and Philippine trenches at depths almost to 7,900 m there is Lethmaster rhipidophorus belonging to the species and genus endemic for these trenches. This species in the Ryukyu trench forms a mass population (found in all three trawling catches obtained in it, and even in one bottom grab sample).

The finding in the Cayman trench (Akademik Kurchatov, st. 1267) was exceptionally interesting: extremely unique minute (less than 1 cm diameter) flat Asteroidea found on a large piece of sunken wood brought up from depth 6,740-6,780 m (see Fig. 39, C). These Asteroidea belonged not only to a new species and genus of Caymanostella spinimarginata, but also to a new family, Caymanostellidae [Beliaev, 1974b]. Other species of this family have been found by now that also live on sunken wood found at lower depths in many other regions [Beliaev, Litvinova, 1977; Wolff, 1979; personal reports of Dr. Ailsa M. Clark, British Museum of Natural History, and Dr. Maureen E. Downey, US Smithsonian Institute], mainly in various regions of the Pacific Ocean, including the Gulf of Panama, and the Caribbean Sea. These Asteroidea have not yet been found in other regions of the Atlantic Ocean. They apparently penetrated into the Caribbean Sea from the Gulf of Panama before the emergence in the Miocene of a land barrier between these regions. It is precisely the Caribbean Caymanostellidae (not yet described) that should apparently be considered the ancestral form of the ultra-abyssal species of the Cayman trench.

The endemism of the Asteroidea found below 6 km on the species level is 40%. Of the 10 defined genera from these depths, only one is endemic, Lethmaster Belyaev, 1969.

OPHIUROIDEA

Ophiuroidea, one of the groups that is very characteristic for the abyssal depths, has also been found below 6 km in the majority of studied trenches and troughs of all three oceans. The greatest depth of finding Ophiuroidea is 8,060-8,135 m in the Kuril-Kamchatka trench (Vityaz, st. 5615). It is true that two Ophiuroidea were found on the photographs even somewhat deeper, at 7,847 m -8,662 m in the Bougainville trench [Lemche et al., 1976]. There are currently 21 known analyses to the taxon species rank (species, subspecies). Ophiuoroidea below 6 km are known in more than 12 genera and 5 families of the order Ophiurae. Representatives of the second order, Euryale, are not known from depths over 6 km.

The data on the family Amphiuridae have not yet been processed. Of the remaining four families, the family Ophiuridae (Appendix II, Table 21) has the most representative species (16 of 21).

The frequency of encounter of Ophiuroidea in the trawling catches from depths from 6 to 8.5 km averages 45%, but the Ophiuroidea, as the Asteroidea, are mainly confined to the upper ultra-abyssal depths:

Level, km	Number of trawlings	Frequency of encounter, %	Level, km	Number of trawlings	Frequency of encounter, %
6-6.5	29	66	7.5-8	11	27
6.5-7	31	52	8-8.5	14	21
7-7.5	24	33			

For the most part, there are few Ophiuroidea in the trawling hauls, but sometimes there are mass catches and they comprise a considerable part of the caught animals. For example, in the Vityaz catch in the Kuril-Kamchatka trench at station 5633, there were

Figure 43. Vertical Distribution of Echinodermata (except Holothurioidea) Known from Depths over 6 km (A) and Change with Depth in Number of Species (1) and Percentage of Endemics (2) (B)

600 specimens of Ophiuroidea, 55% of the total number of animals in the catch; corresponding magnitudes at st. 7291 in the Palau trench were 283 specimens, also 55%, and at two stations in the South Sandwich trench (Akademik Kurchatov, st. 864 and 895), 2,080 specimens (42%) and 150 specimens (14%). There were several species of Ophiruoidea in one haul in a number of cases. As is apparent from Fig. 55, Ophiuroidea in levels 6-6.5, 6.5-7 and 7-7.5 km are in third place in population among all the large groups of animals, inferior only to Holothurioidea and Bivalvia.

Endemism on the species level is 43%. Of the 12 known genera from depths over 6 km, only one is endemic for these depths, Abyssura Belyaev et Litvinova, 1976, known from 5 findings in three northern Pacific Ocean trenches. Of the non-endemic species, the majority are eurybathic, dwelling not only in the abyssal zone, but also at bathyal depths, most often starting from depths over 2-2.5 km.

The summary data regarding the vertical distribution of the Echinodermata (except the Holothurioidea) are presented in Fig. 43. Of the 13 most eurybathic species indicated on this figure, 10 belong to Ophiuroidea.

In both the nature of vertical species distribution, and in the taxonomic affiliation (genera, families), the ultra-abyssal Ophiuroidea fauna are mainly a depleted abyssal fauna.

HOLOTHURIOIDEA

It is completely substantiated that the trench depths may be called the kingdom of Holothurioidea. The frequency of encounter of Holothurioidea in trawling catches below 6 km is 88%, which is only comparable to Polychaeta. Holothurioidea are in first place in population only in some levels of ultra-abyssal depths, approached by Bivalvia in this respect (see Fig. 55). In the upper levels (6-7.5 km) where the fauna are more diverse in a taxonomic respect, Holothurioidea average about 25% of all the animals in the trawling catches, and below 7.5 km their percentage at all depths on the average exceeds 50%. In some catches the Holothurioidea population could reach several thousands, and in these cases their percentage is up to 75-98% of all the caught animals. As is visible from Table 6 that gives information about all the hauls in which the Holothurioidea population exceeded 100 specimens, all of these catches, with the exception of a single exception, are confined to highly-productive

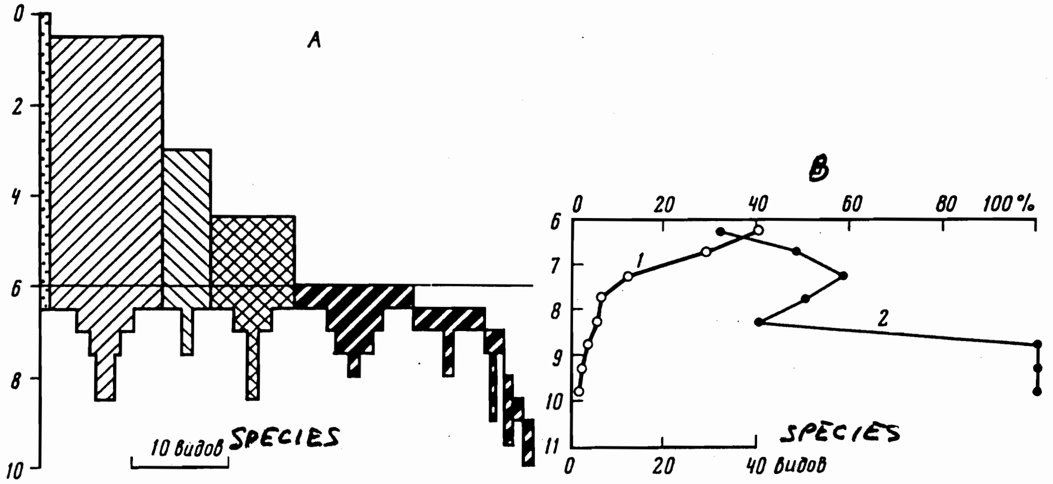

Рис. 43. Вертикальное распространение иглокожих (кроме голотурий), известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) (*Б*)

600 экз. офиур – 55% общего числа животных в улове; соответствующие величины на ст. 7291 в желобе Палау были 238 экз., также 55%, а на двух станциях в Южно-Сандвичевом желобе ("Академик Курчатов", ст. 864 и 895) – 2080 экз. (42%) и 150 экз. (14%). В ряде случаев офиуры в одном улове бывают представлены несколькими видами. Как видно из рис. 55, в горизонтах 6–6,5, 6,5–7 и 7–7,5 км офиуры занимают третье место по численности среди всех крупных групп животных, уступая лишь голотуриям и двустворчатым моллюскам.

Эндемизм на видовом уровне составляет 43%. Из 12 известных с глубин более 6 км родов эндемичен для этих глубин только один – Abyssura Belyaev et Litvinova, 1976, известный по 5 нахождениям в трех желобах северной части Тихого океана. Среди неэндемичных видов большинство эврибатные, обитающие не только в абиссали, но и на батиальных глубинах, чаще всего начиная с глубин более 2–2,5 км.

Суммарные данные о вертикальном распространении иглокожих (кроме голотурий) представлены на рис. 43. Из 13 указанных на этом рисунке наиболее эврибатных видов 10 приходятся на долю офиур.

Таким образом, как по характеру вертикального распространения видов, так и по систематической принадлежности (роды, семейства) ультраабиссальная фауна офиур в основном представляет собой обедненную фауну абиссальной зоны.

ГОЛОТУРИИ – HOLOTHURIOIDEA

Глубины желобов с полным основанием можно назвать царством голотурий. Встречаемость голотурий в траловых уловах с глубин более 6 км составляет 88%, что сопоставимо только с полихетами. По численности же голотурии стоят на первом месте и только в некоторых горизонтах ультраабиссальных глубин к ним приближаются в этом отношении двустворчатые моллюски (см. рис. 55). В верхних горизонтах (6–7,5 км), где фауна в систематическом отношении наиболее разнообразна, голотурии составляют по численности в траловых уловах в среднем около 25% всех животных, а глубже 7,5 км их доля на всех глубинах в среднем превышает 50%. В некоторых уловах численность голотурий может достигать нескольких тысяч, а их доля может в таких случаях составлять до 75–98% всех пойманных животных. Как можно видеть из табл. 6, в которой приведены сведения о всех уловах, в которых численность голотурий превышала 1000 экз., все такие уловы, за единственным исключением, приурочены к высокопро-

TABLE 6
LIST OF TRAWLING CATCHES WITH OVER 100 HOLOTHURIOIDEA SPECIMENS

Key:
1. No. of station
2. Depth, m
3. Number of specimens
4. Number of species
5. Greatest mass species (number of specimens)
6. % of total haul
7. per number of specimens
8. per weight
9. Aleutian trench, Vityaz
10. Kuril-Kamchatka trench, Vityaz
11. Kermadec trench, Galathea
12. Yavan trench, Galathea
13. South Sandwich trench, Akademik Kurchatov
14. Scotia Sea, Akademik Kurchatov

ocean regions, to the northern Pacific Ocean trenches, mainly the Kuril-Kamchatka, to the most eastern Kermadec trench and the sub-atlantic South Sandwich trench. In only one case this catch was obtained in the tropical part of the ocean, in the northeast Indian Ocean (Yavan trench), which is also characterized by high biological productivity. These mass catches are mainly confined to the bottom of the axial part of the trenches where the greatest quantity of the organic remains removed from the trench settle. Based on the Table 6 data I have made a pro forma separation of all the trenches into those confined to areas of moderate and sub-antarctic latitudes, on the one hand, and tropical latitudes on the other hand, and calculated for them the number of trawling catches with varying Holothurioidea population. The results were very indicative (Table 7). Based on sufficiently representative data, the mean population of Holothurioidea in the hauls from the trenches of the highly productive (eutrophic) regions of the temperate and sub-antarctic latitudes are a magnitude greater than in the tropic latitude trenches which are confined for the most part to the less productive or even oligotrophic ocean regions (see, e.g., [Sokolova, 1976, 1981, 1986]), respectively 779 and 63 specimens. It is possible that this difference is slightly exaggerated because of the varying degree of study of the various trenches, but it is most likely that subsequent studies will not make significant changes in the in the resulting pattern.

Insofar as the majority of Holothurioidea (with the exception of the small Myriotrochidae), are the larger animals than the overwhelming majority of other taxonomic groups encountered in the benthos of abyssal and hadal depths, their role in the hauls from depths over 6 km in biobmass is even greater than in population. Their percentage in biomass in the most mass hauls is about 90% and more.

Таблица 6

Список траловых уловов, в которых было более 1000 экз. голотурий

№ станции 1	Глубина, м 2	Число экз. 3	Число видов 4	Наиболее массовый вид (число экз.) 5	% от всего улова 6	
					по числу экз. 7	по весу 8
Алеутский желоб, "Витязь" 9						
6085	6965–7000	1000	3	Peniagone gracilis (992)	83	90
10 Курило-Камчатский желоб, "Витязь"						
5612	8185–8400	1390	5	Elpidia birsteini (1340)	26	90
3176	8175–8840	2200	4	E. hanseni (> 2000)	96	90
2217	9000–9050	3000	2	E. hanseni (3000)	62	?
5627	9170–9335	2800	1	E. hanseni	73	81
5631	9070–9345	8100	2	E. hanseni (8000)	95	97
5613	9030–9530	4500	1	E. hanseni	98	98
5628	9520–9530	15000	2	E. hanseni (15000)	75	96
11 Желоб Кермадек, "Галатея"						
649	8210–8300	1960	2	E. kermadecensis (1800)	93	?
12 Яванский желоб, "Галатея"						
466	7160	3114	2	E. sundensis (3000)	98	?
13 Южно-Сандвичев желоб, "Академик Курчатов"						
898	6052–6150	1580	10	Peniagone incerta (1540)	77	85
866	7694–7934	5850	5	Elpidia ninae (3000) Peniagone herouardi (2000)	78	93
14 Море Скотия, "Академик Курчатов"						
914	5650–6070	1400	4	Elpidia decapoda (1160)	34	50

дуктивным районам океана – к желобам северной части Тихого океана, главным образом к Курило-Камчатскому, к самой южной части желоба Кермадек и к субантарктическому Южно-Сандвичеву желобу. Лишь в единственном случае такой улов был получен в тропической зоне океана – в северо-восточной части Индийского океана (Яванский желоб), которая также характеризуется высокой биологической продуктивностью. В основном такие массовые уловы приурочены к дну осевой части желобов, где оседает наибольшее количество сносимых в желоба с меньших глубин органических остатков. На основании данных табл. 6 я формально разделил все желоба на приуроченные к районам умеренных и субантарктических широт, с одной стороны, и тропических широт – с другой, и подсчитал для тех и других районов число траловых уловов с разной численностью голотурий. Результаты получились чрезвычайно показательными (табл. 7). По достаточно представительным данным, средняя численность голотурий в уловах из желобов высокопродуктивных (эвтрофных) районов умеренных и субантарктических широт на порядок величин выше, чем в желобах тропических широт, большей частью приуроченных к менее продуктивным или даже к олиготрофным районам океана (см., напр.: [Соколова, 1976, 1981, 1986]), – соответственно 779 и 63 экз. Возможно, это различие несколько преувеличено за счет разной степени исследованности различных желобов, но представляется наиболее вероятным, что последующие исследования не внесут в полученную картину существенных изменений.

Поскольку большинство голотурий (за исключением мелких мириотрохид) более крупные животных, чем подавляющее большинство представителей других систематических групп, встречающихся в бентосе абиссальных и хадальных глубин, их роль в уловах с глубин более 6 км по биомассе еще больше, чем по численности. В наиболее массовых уловах их доля по биомассе часто составляет около 90% и более.

TABLE 7. POPULATION OF HOLOTHURIOIDEA IN TRAWLING CATCHES FROM DEPTHS OVER 6,000 m IN VARIOUS OCEAN LATITUDINAL ZONES

Key:
1. Number of Holothurioidea in catches, specimens
2. Temperate and sub-Antarctic latitudes
3. Tropical latitudes
4. Number of stations (%)
5. Mean number of Holothurioidea in catch
6. Approximately
7. None
8. Less than
9. More than
10. Total

The ultra-abyssal Holothurioidea are inferior in diversity of the taxonomic composition only to Crustacea and Polychaeta, and very slightly to the Gastropoda and Bivalvia. Species analyses (Appendix II, Table 22) are known by now for 55 species rank taxons (species, subspecies, including new species whose descriptions have not yet been published). But this number undoubtedly will rise significantly after materials have been processed for a number of groups from the collections of all expeditions (except for the completely evaluated collections of the Galathea expedition), including from the numerous Soviet expedition collections (for some catches only some preliminary descriptions are known in field logs). These groups include Holothurioidea of the order Molpadonia (including the family Gephyrothuriidae whose representatives are fairly numerous in many trenches all the way to the greatest depths, but whose taxonomic position is generally not sufficiently clear), partially representatives of the order Elasipoda, as well as the family Synalactidae (now included in the order Aspidochirota).

The most important in the trench benthic biocenses are Holothurioidea of the order Elasipoda, mainly the family Elpidiidae. This family includes 29 already defined taxons of species rank from seven genera. The second significant group is the family Myriotrochidae (order Apoda), represented below 6 km by 18 taxons of species rank from four genera. Only from one to four species have been defined from the other ultra-abyssal families and orders.

Figure 44 shows the vertical dissemination of the hadal Holothurioidea. The species endemism of the Holothurioidea hadal fauna is 69%. The endemic species generally live either in some one trench, or in several adjoining trenches. There is only one known endemic genus, Hadalothuria Hansen, 1956. Of the non-endemic species, 6 do not rise above the abyssal, and the remaining 11 are eurybathic, also known from the bathyal depths, and in two cases, even from the shelf. Apparently, however, after systematic revisions of the corresponding groups, the number of these species could decrease significantly. Regarding one of the most eurybathic species, Mesothuria murrayi, B. Hansen [1956] notes that the taxonomy of this and its close species is very muddled and this group needs to be revised. Scotoplanes globosa (Theel) was previously considered eurybathic, in which Hansen [1956, 1967, 1975] also included representatives of this genus, found in the Kermadec trench at depths to 6,770 m. However, based on images of the skin spicules cited in Hansen's publication [1967] it was clear that specimens from the hadal and shallower depths differ strongly. This was confirmed as a result of A. V. Gebruk's [1983b] evaluation of extensive materials from Soviet expedition collections on the genus Scotoplanes and review of this genus. It was found that all the representatives of this genus living below 6 km in several trenches

Таблица 7

Численность голотурий в траловых уловах, полученных с глубин более 6000 м в разных широтных зонах океана

Число голотурий в улове, экз. 1	Умеренные и субантарктические широты 2		3 Тропические широты	
	Число станций (%) 4	Среднее число голотурий в улове 5	Число станций (%) 4	Среднее число голотурий в улове 5
Отсутствуют 7	3 (4)	0	15 (19)	0
Менее 20 8	25 (36)	6 Около 5	43 (55)	6 Около 5
21–100	15 (22)	55	14 (18)	58
101–1000	14 (20)	270	5 (6,5)	150
Более 1000 9	12 (18)	4082	1 (1,5)	3114
Всего 10	69 (100)	779	78 (100)	63

По разнообразию систематического состава ультраабиссальные голотурии уступают только ракообразным и полихетам и очень незначительно брюхоногим и двустворчатым моллюскам. К настоящему времени видовые определения (Приложение II, табл. 22) известны для 55 таксонов видового ранга (виды, подвиды, включая новые виды, описания которых пока не опубликованы). Но это число несомненно значительно возрастает после обработки материалов по ряду групп из сборов всех экспедиций (кроме полностью обработанных сборов экспедиции на "Галатее"), в том числе из наиболее многочисленных сборов советских экспедиций (для некоторых уловов пока известны лишь предварительные описания их в полевых журналах). К таким группам относятся голотурии отряда Molpadonia (включая семейство Gephyrothuriidae, представители которого довольно многочисленны во многих желобах вплоть до самых больших глубин, но систематическое положение которых вообще пока недостаточно ясно), частично представители отряда Elasipoda, а также семейства Synalactidae (пока включаемого в отряд Aspidochirota).

Наиболее велико значение в донных биоценозах желобов голотурий отряда Elasipoda, в основном семейства Elpidiidae. К этому семейству относятся 29 уже определенных таксонов видового ранга из семи родов. Вторая по значимости группа – семейство Myriotrochidae (отряд Apoda), представленное глубже 6 км 18 таксонами видового ранга из четырех родов. Из других представленных в ультраабиссали семейств и отрядов пока определено лишь от одного до четырех видов.

Вертикальное распространение хадальных голотурий показано на рис. 44. Видовой эндемизм хадальной фауны голотурий составляет 69%. Как правило, эндемичные виды обитают либо в каком-нибудь одном желобе, либо в нескольких смежных желобах. Эндемичный род известен только один – Hadalothuria Hansen, 1956. Из неэндемичных видов 6 не поднимаются выше абиссали, а остальные 11 эврибатные, известные также с батиальных глубин, а в двух случаях даже с шельфа. По-видимому, однако, после проведения систематических ревизий соответствующих групп число таких видов может значительно уменьшиться. Так, в отношении одного их самых эврибатных видов – Mesothuria murrayi Б. Хансен [Hansen, 1956] отмечает, что таксономия этого и близких к нему видов очень запутана и эта группа нуждается в ревизии. Ранее считался эврибатным видом Scotoplanes globosa (Théel), к которому Хансен [Hansen, 1956, 1967, 1975] относил и представителей этого рода, найденных в желобе Кермадек на глубинах до 6770 м. Однако уже по изображениям спикул кожи, приведенным в работе Хансена 1967 г., было ясно, что особи с хадальных и с меньших глубин сильно различаются. Это подтвердилось в результате проведенной А.В. Гебруком [1983б] обработки обширных материалов из сборов советских экспедиций по роду Scotoplanes и ревизии этого рода. Оказалось, что все обитающие глубже 6 км в нескольких желобах

Figure 44. Vertical Dissemination of Holothorioidea Known from Depths over 6 km (A0, and Change with Depth in the Number of Species (1) and Percentage of Endemics (2) (B)

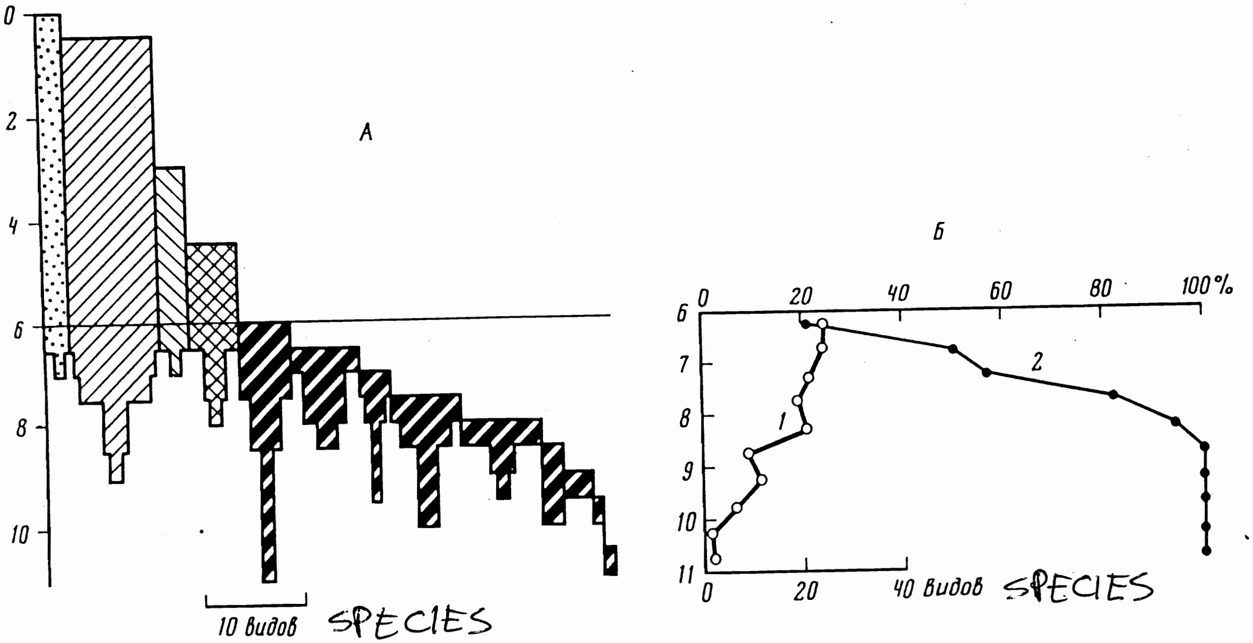

Рис. 44. Вертикальное распространение голотурий, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (1) и процента эндемиков (2) (*Б*)

belong to a special species S. hanseni Gebruk that are disseminated at depths from 4,800 to 7,075 m. The species Peniagone vedeli described by Hansen [1956] as endemic for the Kermadec trench and known from five findings at depths from 6,140 to 8,300 m, was later inventoried by Hansen [1967, 1975] in synonymy of previously known eurybathic species, initially the species P. willemosi (Theel), and then P. azorica Marenzeller. But based on the unique spicules I believe it is more correct to consider this species to be independent, leaving it under the initial name P. vedeli.

As for yet another eurybathic species, Benthodytes sanguinolenta that Hansen [1956, 1975] classifies with individuals found in the Banda trench at depths from 6,430 to 7,290, the indistinctness of the taxonomic signs of this Holothurioidea species has been noted repeatedly [H. L. Clark, 1920; Hansen, 1956, 1975] since they do not have skin spicules (only in the tentacles and legs); the identification of representatives of these Holothurioidea populations from various habitats are insufficiently reliable since it is based on a comparison of only small body parts. The volume of this species should therefore be considered unresolved.

Per the analysis of A. V. Gebruk (personal report), in the South Sandwich trench and in the Scotia Sea at depths up to 6,150 m the Antarctic species Amperima velacula is encountered, which is also known from depths of the Antarctic shelf, but the rise in the Antarctic of deep-sea species to shallower depths is apparently fairly common.

Despite the fact that B. Hansen in a number of cases does not consider the differences between hadal and shallower deep-sea populations to be sufficient to separate them into independent species, he made a very convincing statement: " Physiological adaptation to life under high pressure plays a possible role in minimizing the flow of genes in a vertical direction, thus accelerating the separation that starts because of topographical isolation" [Hansen, 1967, p. 498].

In examples of representatives of the family Myriotrochidae that are very characteristic for the majority of trenches, on the one hand [Beliaev, Mironov, 1982], and the genus Elpidia on the other hand [Beliaev, 1975], it was shown that in the first case we are dealing with a secondary deep-sea group, and in the second case, with a primary, or ancient deep-sea group.

The family Myriotrochidae, based on recent data [Beliaev, Mironov, 1982; Gage, Billet, 1986], includes about 46 species taxons (including several species that have not been fully defined because of the fragmentary nature of the available materials). These species include 20 that are distributed in depths from 2 m to 3,000 m (sublittoral, sublittoral-bathyal and bathyal species), 8 species disseminated only at abyssal depths, 1 species of abyssal-hadal and 17 species (including subspecies) of those endemic for depths over 6 km and known from 16 trenches all the way to depth 10,730 m. Representatives of this family are thus currently distributed at all ocean depths (Fig. 45). Fossil calcareous spicules that have the appearance of trochi that are very characteristic for this family are known from numerous findings in Europe and one from the southern tip of Hindustan from shallow Mesozoic and Cenozoic deposits, starting from the Triassic and Lower Jurassic [Frizzel, Exline, 1966; Beliaev, Mironov, 1982; Kozur et al., 1985]. The most ancient of these findings are very similar to the trochi of the modern Atlantic bathyal-abyssal species Acanthotrochus mirabilis Dan.et Koren (personal report of A. V. Smirnov). The paleontological data thus support the fact that the Miriotrochidae family was formed back in the Mesozoa at shallow depths of the Tetis Sea, broad dissemination in the World Ocean abyssal and settlement of many deep-sea trenches apparently occurred recently in the geological sense, in the Tertiary or even Quaternary period [Beliaev, Mironov, 1982].

Dissemination of the deepest families of the order Elasipoda, Elpiidae and Psychropotidae is confined predominantly to the abyssal depths (see: [Beliaev, 1974a, Fig. 1]). Representatives of both families also penetrated to deep-sea trenches

Figure 45. Dissemination of Holothurioidea Genera of Family Myriotrochidae

Key:

1. Acanthotrochus
2. Lepidotrochus
3. Myriotrochus
4. Prototrochus
5. Siniotrochus
6. Trochoderma
7. Parvotrochus
8. Myriotrochidae gen. sp.
9. Findings of fossil sclerites Miriotrochidae from the Triassic to the Pleistocene.

The letters designate the abbreviated names of the trenches in which Miriotrochidae were found.

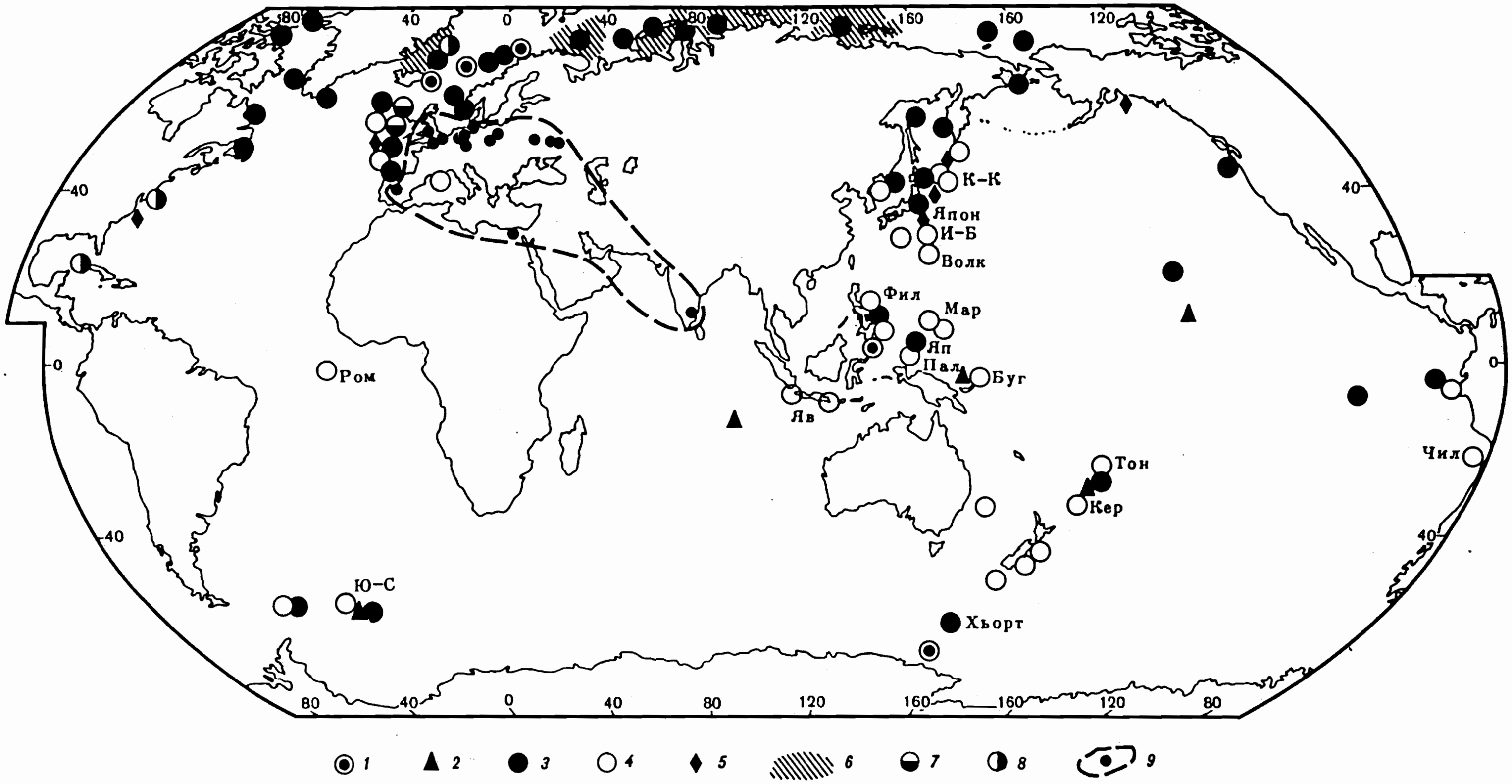

Рис. 45. Распространение родов голотурий сем. Myriotrochidae

1 – Acanthotrochus; *2* – Lepidotrochus; *3* – Myriotrochus; *4* – Prototrochus; *5* – Siniotrochus; *6* – Trochoderma; *7* – Parvotrochus; *8* – Myriotrochidae gen. sp., *9* – находки ископаемых склеритов (колес) мириотрохид от триаса до плейстоцена. Буквами обозначены сокращенные названия желобов, в которых найдены мириотрохиды

and Elpidiiae on the trench floor of eutrophic ocean regions comprise the greatest mass of their fauna (see Table 6). Judging from the vertical dissemination, the formation and evolution of these families should occur in the abyssal [Hansen, 1967; Beliaev, 1974a]. As for the family Elpidiidae, then apparently its formation occurred in the deep-sea regions (in the bathyal or abyssal) of the Antarctic where the genus Protelpidia Gebruk characterized by primitive signs is disseminated "...apparently one of the closest among the modern forms to the hypothetical precursor group for the entire family" [Gebruk, 1983a, p. 1040].

The genus Elpidia which is extremely characteristic for many trenches currently includes no less than 25 species (including yet undescribed species from trenches Yap, Palau, Romanche and 2 new species from the Arctic basin abyssal): 15 species were found in different deep-sea trenches at depths up to 9,530 m, several species dwell at bathyal and abyssal depths and 1 species, E. glacialis s.str. is disseminated at sublittoral Arctic sea shelf depths (for more detail about the volume of the species E. glacialis see: [Beliaev, 1971b]). Based on the structural nature of the calcareous skin spicules the most primitive are the bathyal Antarctic species and the species disseminated in the Antarctic abyssal and other ocean regions. The species of the deep-sea trenches are the most specialized with complex or modified spicules. On this basis I drew the conclusion that the formation of the Elpidia genus should have occurred in the Antarctic bathyal or abyssal. The Elpidia settled and formed from here from the cold deep waters into the abyssal of various ocean regions of their endemic species (Fig. 46). The latter were the original forms for isolation in the deep-sea trenches of the ultra-abyssal species endemic for each trench for the group of neighboring trenches [Beliaev, 1975]. In some cases, within one trench as all ever greater depths are settled there was formation in different levels of their stenobathic species as is graphic in the example of the group of species from the Kuril-Kamchatka trench: E. kurilensis 6,675-8,100 m (in addition to the Kuril-Kamchatka, the Aleutian and Japan trenches), E. longicirrata 8,035-8,345 m, E. birsteini and E. hanseni 8,060-9,345 and 8,610-9530 m. In the latter case, the two species living at similar depths differ strongly in their morphology, and apparently, were distributed in ecological niches. The latter two species are also known from depths over 8,500 m from the Izu-Bonin trench. E. birsteini from both trenches are morphologically similar, while E. hanseni is represented in the Izu-Bonin trench by a special subspecies, E. h. idsubonensis. The greatest depths of the discussed trenches are currently separated by lower depths of the Japan trench, even individual basins of the greatest depths of which do not exceed 8,400 m. However, all three of these trenches were apparently previously united by depths on the order of 8,500-9,000 m and the isolation of such depths in the Kuril-Kamchatka and Izu-Bonin trenches occurred only comparatively recently.

In the western tropical Pacific Ocean trenches different Holothurioidea were also found on numerous bottom photographs obtained at depths to 9 km by the PROA expedition [Lemche et al., 1976]. They calculated the population density for several Holothurioidea species from the Elpidiidae family based on photographs covering a certain bottom area (from 0.5 to 10 m^2).

The population density for Elpidia uschakovi in the New Hebrides trench (st. 11, 6,758-6,776 m) was 1 specimen per 10 m^2 of floor (calculation from photographs covering a total area of 1,110 m^2). The population density for E. solomonensis from the New Britain trench (st. 5, 6, 7) and Bougainville (st. 8) was from 3 to 10 in the first and 1 specimen/100 m^2 in the second (calculations from photographs covering a total bottom area at st. 5 of 375 m^2, at st. 7 of 250, at st. 7 of 2,075 and at st. 8 of 1,375 m^2). For Elpidia sp. from the Palau trench (st. 2) the corresponding quantity was 1 specimen/10 m^2 (for area 1,200 m^2). At the same station the population density of Peniagone purpurea was also 1 specimen/10 m^2. The corresponding indicators for P. azorica from the trenches

Figure 46. Diagram of Dissemination of Holothurioidea of Genus Elpidia, Location of the Proposed Formation Area of the Genus (Hatched Area) and Its Settlement Paths (Arrows)

Species of group that is the closest to the original form, abyssal (1--E. theeli, 2--E. chilensis, 3--E. minutissima, 4--E. gracilis, 5--E. adenensis) and bathyal (6--E. antarctica); species of the Yavan trough (7--E. sundensis, 8--E. javanica): species of the west Pacific Ocean trenches (9--E. kermadecensis, 10--E. uschakovi, 11--E. solomonensis); species of the north Pacific Ocean trenches (12--E. kurilensis, 13--E. birsteini, 14--E. longicirrata, 15--E. hanseni); 16--E. atakama from the Chile trench; species of South Sandwich trench (17--E. decapoda, 18--E. ninae, 19--E. lata); Arctic species (20--E. glacialis, 21--Elpidia sp. from the Baffin Sea); circles--findings of Elpidia whose species affiliation has not been determined [per: Beliaev, 1975]

of New Britain (st. 6 and 7) and Bougainville (st. 8) were 3, 1 and 3 specimens/100 m^2, and for Scotoplanes hanseni in the New Britain trench (st. 7) 3 specimens/100 m^2 and in the New Hebrides (st. 11) 1 specimen/100 m^2. If one considers that the listed Holothurioidea, when alive, weigh from several to at least 10-20 g, and we calculate the corresponding indicators into biomass, then we obtain quantities from tens of fractions to several g/m^2, indicators that are very significant for the tropical zone trenches.

ECHINOIDEA

Echinoidea have been found below 6 km in 9 trenches and 3 troughs of all three oceans, but almost all of the findings have been confined to depths less than 7 km, and in only two trenches, Palau and Banda, have Echinoidea been found somewhat deeper. The greatest depth of Echinoidea dissemination is 7,340 m in the Banda trench. The frequency of encountering Echinoidea in trawling hauls in the depth range from 6,000 to 7,340 m is 31%. All the collections from depths over 6 km have already been evaluated. They include 7 species (one with two subspecies) from genera of four families and several analyses only to the genus level because of fragmentary material that was insufficient for more accurate identification. Only one species

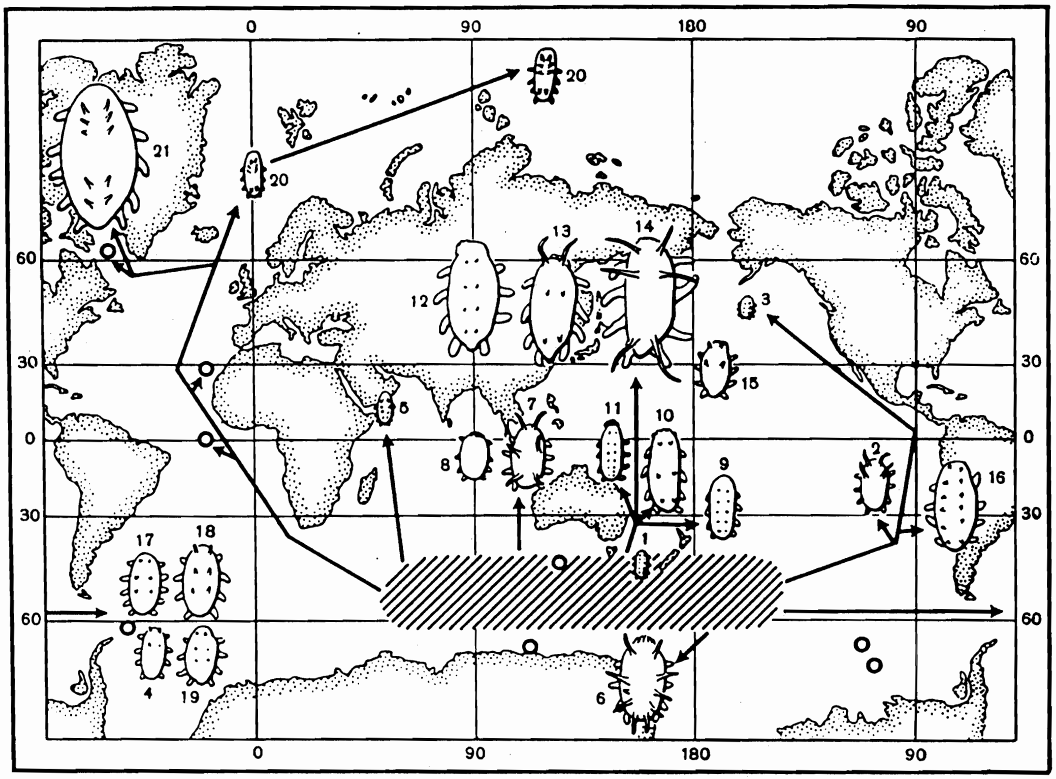

Рис. 46. Схема распространения голотурий рода Elpidia, положение предполагаемой области формирования рода (заштрихована) и путей его расселения (стрелки)

Виды группы, наиболее близкой к исходной форме, – абиссальные (*1* – E. theeli, *2* – E. chilensis, *3* – E. minutissima, *4* – E. gracilis, *5* – E. adenensis) и батиальный (*6* – E. antarctica); виды Яванского желоба (*7* – E. sundensis, *8* – E. javanica); виды западнотихоокеанских желобов (*9* – E. kermadecensis, *10* – E. uschakovi, *11* – E. solomonensis); виды желобов северной части Тихого океана (*12* – E. kurilensis, *13* – E. birsteini, *14* – E. longicirrata, *15* – E. hanseni); *16* – E. atakama из Чилийского желоба; виды Южно-Сандвичева желоба (*17* – E. decapoda, *18* – E. ninae, *19* – E. lata); арктические виды (*20* – E. glacialis, *21* – Elpidia sp. из моря Баффина); кружки – места нахождения эльпидий, видовая принадлежность которых не установлена [по: Беляеву, 1975]

бов Ново-Британского (ст. 6 и 7) и Бугенвильского (ст. 8) были 3, 1 и 3 экз./100 м^2, а для Scotoplanes hanseni в Ново-Британском желобе (ст. 7) – 3 экз./100 м^2 и в Ново-Гебридском (ст. 11) – 1 экз./100 м^2. Если учесть, что перечисленные голотурии, будучи живыми, весят от нескольких до по крайней мере 10–20 г, и пересчитать соответствующие показатели на биомассу, то мы получим величины от десятых долей до нескольких г/м^2 – показатели, весьма значительные для желобов тропической зоны.

МОРСКИЕ ЕЖИ – ECHINOIDEA

Морские ежи встречены глубже 6 км в 9 желобах и 3 котловинах всех трех океанов, но почти все нахождения приурочены к глубинам менее 7 км, и лишь в двух желобах – Палау и Банда – морские ежи встречены несколько глубже. Наибольшая глубина распространения морских ежей – 7340 м в желобе Банда. Частота встречаемости морских ежей в траловых уловах в диапазоне глубин от 6000 до 7340 м – 31%. Все сборы с глубин более 6 км уже обработаны. Они включают 7 видов (один с двумя подвидами) из 6 родов четырех семейств и несколько определений лишь до рода из-за фрагментарности материала, недостаточной для более точной идентификации. Лишь один вид отно-

belongs to the order of soft Echinoidea, Echinothuroida, all the other findings refer predominantly to the deep-sea order Spatangoida (Appendix II, Table 23). Two species and one subspecies are endemic for depths over 6 km (38% of the species rank taxons). Of the non-endemic species, 4 are found beyond the trenches only at abyssal depths and only one is known starting from depth 2,600 m. There are no endemic ultra-abyssal genera.

There are usually few Echinoidea in the trawling catches, but Spatangina with very brittle shells are often represented only by fragments. The Echinoidea apparently form a mass population at the maximum habitat depth in the Banda trench. The species Pourtalesia heptneri Mironov that lives here has been found in all three trawling hauls obtained in this trench, and in the catch from the greatest depth 7,340 m (Vityaz, st. 7271) there were 24 whole individuals and shell fragments of no less than another 120 specimens. It is important that on all the whole samples of this species small Bivalvia of the Montacutidae family were attached to the spines surrounding the oral cavity [Mironov, 1978b]. Similar cases of symbiosis with Montacuta genus mollusks have been noted repeatedly for other species of the Pourtalesia genus at considerably shallower depths (see, e.g.: [Gage et al., 1985]). Echinoidea were numerous in another two trawling hauls. In the Yavan trench the subspecies Echinosigra amphora indica Mironov endemic for it was found in two of the six hauls obtained in this trench, including in one (Vityaz, st. 4535, 6,820-6,850 m) with 32 specimens of these Echinoidea. It is characteristic that in the Yavan trench that in direct proximity to the abyssal depths of the Indian Ocean there was a massive representation of the Echinosigra abyssal genus, while in the Banda trench that is isolated from the open ocean abyssal the new mass species found in it is classified as the eurybathic genus Pourtalesiak, one of whose representatives is known from the Indian-Malaysian archipelago bathyal. Yet another case of detection of a mass population of the new sub-Antarctic species Pourtalesia aff. debilis Koehler is confined to the catch made in the Scotia Sea in depths ranging from 5,650 to 6,070 m (Akademik Kurchatov, st. 914). This haul found many fragments of shells of Echinoidea of this species belonging to no less than 1,150 individuals [Vinogradova et al., 1974; Mironov, 1974, 1978a].

POGONOPHORA

As a result of the intensive study of Pogonophora in recent decades, the number of known species of this group is continuously rising. About 180 species are currently known. No less than 29 species have been found at depths over 6 km (some of the collected materials have not yet been defined), i.e., about 16% of the total number of known species. Only 7 of these species have been found at lower depths: 5 have not risen above the abyssal, there is one known each from bathyal depths (1,950 m) and sublittoral (22 m). As for the last species, Siboglinum caulleryi, this is a characteristic, sometimes mass form of Sea of Okhotsk benthos where this species dwells at depths of the shelf and continental slope from 22 to 1,518 m. Typical individuals of this species were found only once in the Kuril-Kamchatka trench at depth 8,100 m [Ivanov, 1960a]. Insofar as A. V. Ivanov did not find differences between individuals from the shoal populations of the Sea of Okhotsk and the ultra-abyssal population, and at intermediate abyssal depths this species was never found, it could be hypothesized that S. caulleryi settled in the Kuril-Kamchatka trench only recently and the ultra-abyssal form could not be morphologically isolated from the shallow form, although the trench population was undoubtedly isolated reproductively from the other populations.

The 22 species are endemic for the ultra-abyssal zone (76%), and each of them is confined only to some one trench or to several neighboring trenches (Appendix II, Table 24). It is characteristic that all the known species from the trenches, but not endemic for them are disseminated beyond the limits of each trench at shallower depths only in the neighboring ocean region which graphically indicates the local source for the origin of Pogonophora fauna in each trench. The greatest known depth of finding Pogonophora fauna is 9,715-9,735 m in the Izu-Bonin trench (Heptabranchia subtilis endemic for this trench).

Undefined close Pogonophora have been found at several other stations by exeditions: on Vityaz in the Aleutian, Kuril-Kamchatka and Japan trenches, on Akademik Kurchatov in the Peru trench and on Dmitriy Mendeleyev in the Hjort trench. The frequency of encountering Pogonophora in trawling catches from the trenches is 28%. Pogonophora are apparently in many hauls obtained by other expeditions below 6,000 m for which data on the composition of the caught animals has not yet been published.

All 6 families of the Phrenulata[1] class are represented in the ultra-abyssal and 10 of the 15 known genera, including one (Cyclobrachia Ivanov, 1960) endemic for this zone. Being mainly deep-sea animals, Pogonophora nevertheless are almost never found far from shores. "As filterers/microplankton-eaters Pogonophora depend on the quantity of detritus suspended in the water and the bacterial flora developing on it. They are therefore more common in places where there are more or less constant local concentrations of near-bottom organic suspended matter. This also explains their absence in open ocean spaces far from continents" [Ivanov, 1963, p. 97]. This apparently explains why Pogonophora have never been found in the open ocean trenches (Volcano, Mariana, Yap, Palau, New Hebrides, Tonga, Kermadec, Romanche) or in deep-sea troughs far from shores.

Pogonophora are especially abundant and diverse in the Kuril-Kamchatka trench where they are represented by no less than ten species. The frequency of encountering Pogonophora in this trench is 50%. There were about 1,500 Pogonophora of six species in the trawling catch from 9,000 m (Vityaz, st. 2217). The majority of them belong to one species, Zenkevitchiana longissima whose length of the white leathery tube reaches 1.5 m, and the length of the actual animal 36 cm [Ivanov, 1960a]. Pink animals (from the hemoglobin in the blood) were located in most of the tubes and their bodies shone through the tube. In this catch, Z. longissima was second in population, giving way only to the Holothurioidea Elpidia hanseni. It is true that this is the only case of such a mass finding of Pogonophora in the trenches. Usually there are very few in the trawling catches.

HEMICHORDATA

ENTEROPNEUSTA

Until recently Enteropneusta were considered to be confined predominantly to shallow depths, including littoral waters. Only three findings were known from abyssal depths (2,910-4,545 m) made on the Challenger expedition. It was therefore unexpected to find several specimens of Enteropneusta in a trawling haul obtained in 1949 in the Kuril-Kamchatka trench from depth 8,100 m [Uschakov, 1952]. These animals belonged to a new species, Glossobalanus tuscarorae Belichov [Belichov, 1971] (Fig. 47, A).

In 1966, about 20 specimens of Enteropneusta were again caught in the Kuril-Kamchatka trench in the same region and almost at the same depth (Vityaz, st. 5616, 7,795-8,015 m) as previously. Enteropneusta were found both times on the ocean side of the trench where apparently considerable settlements are formed at depth about 8 km. Single individuals of Enteropneusta in 1969 were again collected by Vityaz, but now in the Aleutian trench at depths from 6,520 to 7,250 m (st. 6085, 6139 and 6145). Then one specimen of Enteropneusta was found

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[1] Representatives of the Aphrenubata or Vestimenifera class have not been found at depths over 6 km.

Figure 47. Enteropneusta Glossoblanaus tuscarorae (A), Kuril-Kamchatka Trench, 8,100 m [per: Belikhov, 1971] and Leophenteropneusta (B, C). B One of the photographs from the New Britain trench at depth 8,260 m; C. Graphic reconstruction of this animal [per Lemche et al., 1976]

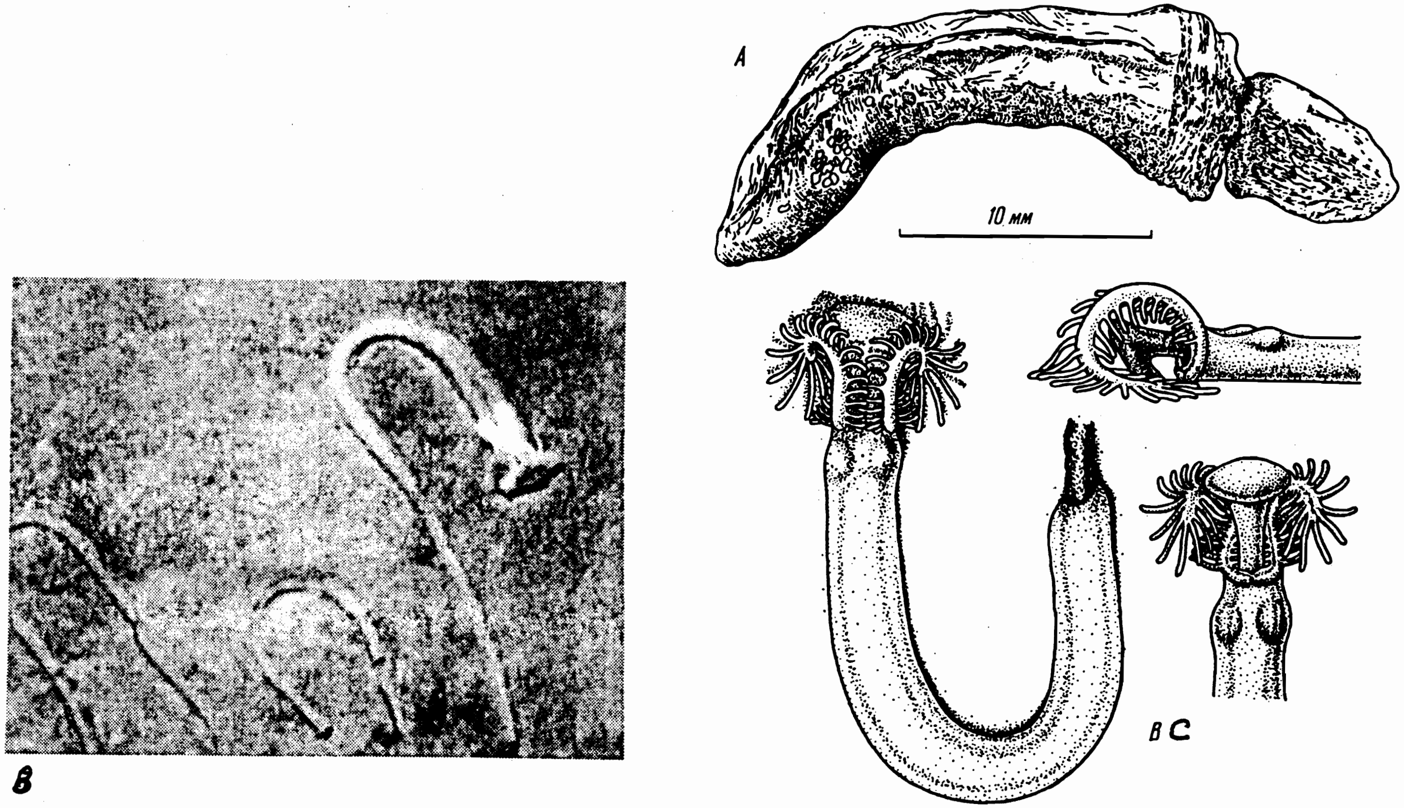

Рис. 47. Enteropneusta – Glossobalanus tuscarorae (*А*), Курило-Камчатский желоб, 8100 м [по: Белихову, 1971], и Lophenteropneusta (*Б, В*)
Б – одна из фотографий, полученных в Ново-Британском желобе на глубине 8260 м; *В* – графическая реконструкция этого животного [по: Lemche et al., 1976]

Figure 48. Lophenteropneusta from Other Ocean Regions

Key:

A. Kermadec trench slope, 4,735 m, area of photographed bottom about 5 m^2 [per: Bourne, Heezen, 1965]
B. Equatorial Pacific, 5,089 m [per: Thiel, 1969]

sub-Antarctic trenches South Sandwich and Hjort (Akademik Kurchatov, st. 867, 8,004-8,116 m, and Dmitriy Mendeleyev, st. 1305-2, 6,200-6,2300 m) [Vinogradova et al., 1974, 1978].

As far as it is known from shallow representatives, the majority of Enteropneusta dwell in U-shaped holes dug into the soil, and displaying the body rear end to the outside, form on the soil surface hills of spirally twisted fecal braids (similar to the Polychaeta sand eel Arenicola) (see: [Vinogradova, 1968]).

Further data about the dissemination in the ocean of deep-sea Hemichordata representatives are based on the technique of underwater photography developed in recent decades. Many photographs of the ocean floor obtained at abyssal

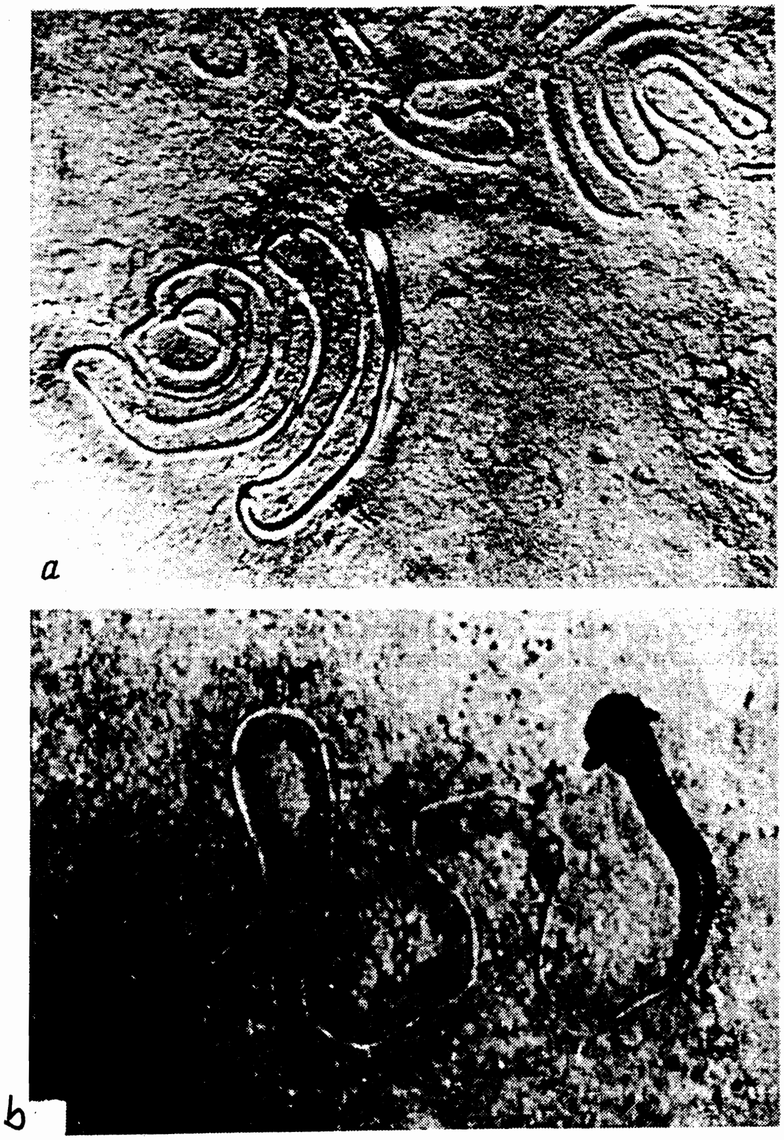

Рис. 48. Lophenteropneusta из других районов океана

А – склон желоба Кермадек, 4735 м, площадь сфотографированного участка дна около 5 м^2 [по: Bourne, Heezen, 1965]; *Б* – экваториальная Пацифика, 5089 м [по: Thiel, 1979]

антарктических желобах Южно-Сандвичевом и Хьорт ("Академик Курчатов", ст. 867, 8004–8116 м, и "Дмитрий Менделеев", ст. 1305-2, 6200–6230 м) [Виноградова и др., 1974, 1978].

Насколько известно по мелководным представителям, большинство Enteropneusta обитают в вырытых в грунте *U*-образных норах и, выставляя наружу задний конец тела, образуют на поверхности грунта горки спирально закрученных фекальных шнуров (подобно полихете-пескожилу Arenicola) (см.: [Виноградова, 1968]).

Дальнейшие данные о распространении в океане глубоководных представителей типа полухордовых связаны с развитием в последние десятилетия техники подводного фотографирования. На многих фотографиях дна океана, полученных на абиссальных

depths showed enigmatic formations in the form of thin, spiral cylinders or twisted loops. Their nature remained unknown until the Vema expedition was able to obtain a photograph in the southern Pacific Ocean at depth 4,735 m which clearly shows an enormous animal (about 1 m in length) together with the spiral that it left (Fig. 48, A). This animal was then defined as a representative of Enteropneusta, and the spiral was its fecal funiculus [Bourne, Heezen, 1965], although these feces were not similar to these shallow-water Enteropneusta. Bottom photographs with similar formations were obtained on the ocean floor in many regions (see, e.g.: [N. Zenkevitch, 1970; Heezen, Hollister, 1971]) which indicates that these animals are widespread in the abyssal World Ocean.

LOPHENTEROPNEUSTA

Many photographs of the floor in three trenches, New Britain, Bougainville and New Hebrides (Spencer F. Baird, st. 5, 8 and 11) showed very characteristic funiculi in the form of loops or spirals that were similar to those previously known from abyssal depths. In 16 instances, at the end of the these funiculi the actual animals were also photographed (see Fig. 47, B) with a transparent cylindrical body, 5-10 cm long and about 0.5-1 cm thick [Lemche et al., 1976]. The graphic reconstruction (see Fig. 47, C) made from the stereoscopic color photographs indicated that this animal has features inherent to representatives of two classes of Hemichordata, Enteropneusta and Pterobranchia. Lemche et al. isolated these animals into a separate group, Lophenteropneusta (i.e., Enteropneusta with lophophral feelers). This group apparently corresponds to the taxon order or class. These animals float to the surface of the silt and collect its upper organic matter-enriched layer (detritus), thus making scanning motion by their front end. Lemche et al. hypothesize that this animal may sometimes float up from the bottom. The mean population density of Lophenteropneusta in the three aforementioned trenches trenches was 1 specimen per 100 m^2/floor. The animals in this group, apparently widespread in the abyssal and ultra-abyssal zones, include several species, of which two (judging from different types of fecal funiculi) dwell in the studied trenches over 6,000 m, and representatives of at least another three species are apparent on photographs where they were previously classified as Enteropneusta obtained [Bourne, Heezen, 1965; Ewing, Davis, 1967] at three stations in the Pacific and Indian Oceans [Lemche et al., 1967]. H. Thiel [1979] several years ago cited yet another photograph of Lophenteropneusta (Fig. 48 B) obtained in the equatorial Pacific at depth 5,090 m.

CHORDATA

ASCIDIAE

There are few Ascidiae at depths over 6,000 m. The frequency of finding them in trawling samples from these depths is about 25%. The majority of findings are confined to troughs and trenches in the northern and western Pacific Ocean. Ascidiae were caught in this part of the ocean in three hauls at depths 6,000-6,300 m in the northeast and northwest troughs, as well as in a number of samples from the Aleutian, Kuril-Kamchatka, Japan, Volcano, Philippine and Ryuyuko trenches obtained from depths 8,430 m. Ascidiae were also found in the Kermadec, Peru, Romanche and South Sandwich trenches (in the latter in all the trawling samples) [Vinogradova et al., 1974]. Ascidiae are also represented on the photographs obtained in the New Britain and New Hebrides trenches (see Appendix II, Table 25).

The currently defined species or genera belong to five families of single Ascidiae. One species (Culeolus robustus) was only found at depth over

Figure 49. Ascidiae

Key:

a. Situla pelliculosa, Kuril-Kamchatka trench, 8,400 m
b. Culeolus robustus, Ibid, 7,265-7,295 m
[per: Vinogradova, 1969, 1970];
c. New genus and species from fam. Hexacrobilidae, Volcano trench, 6,330 m;
d. Octacnemus sp. (fam. Octacnemidae), Kuril-Kamchatka, 8,185-8,400 m)

7,000 m, the other Ascidiae, whose species affiliation has already been defined, were found not only in the trenches but also beyond the abyssal area or its lower subzone. The very unique Ascidiae, Situla pelliculosa (Fig. 49), described by N. G. Vinogradova [1969a], the deepest of all the Ascidiae, was only found in the Kuril-Kamchatka trench region at depths from 5,000 to 8,400 m. Yet another species of this genus was then also described from several findings in the Atlantic Ocean in the area between the Azores and the Bay of Biscay at depths from 2,115 to 4,690 m [C. Monniot, F. Monniot, 1973], and then another two species were found somewhat deeper than 5.5 km in the area of the South Sandwich trench [Vinogradova, 1975].

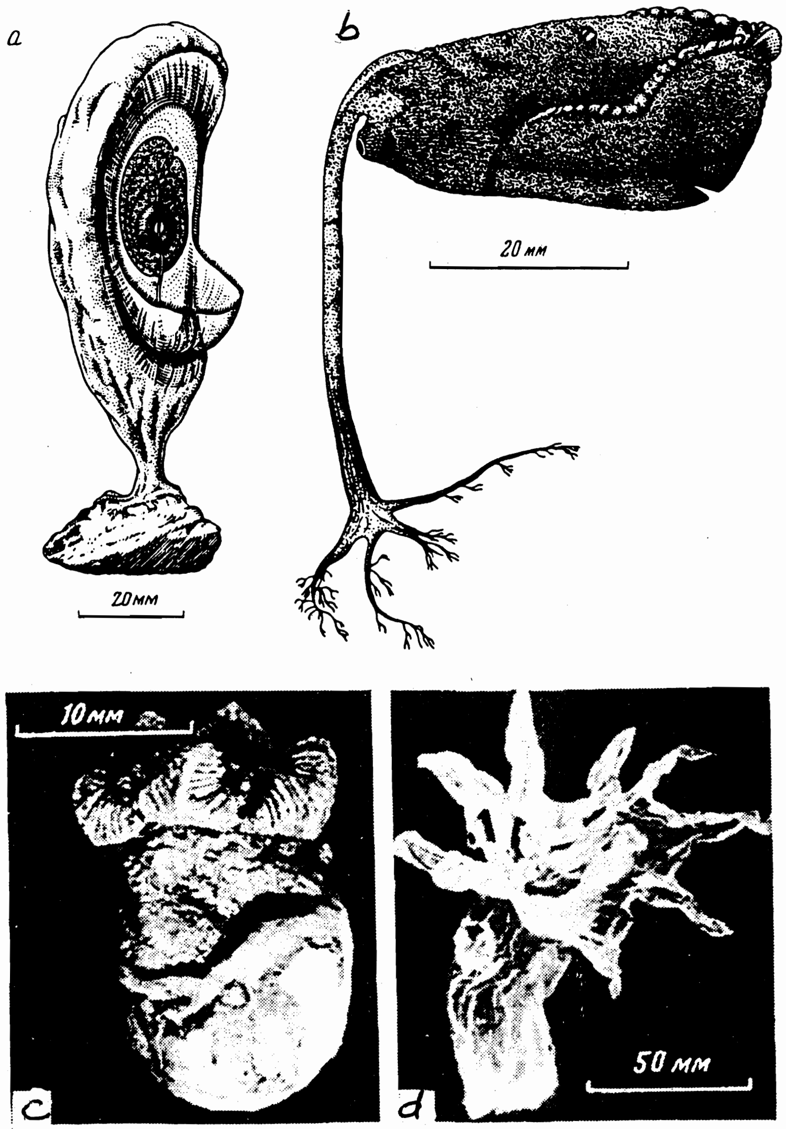

Рис. 49. Асцидии

а – Situla pelliculosa, Курило-Камчатский желоб, 8400 м; *б* – Culeolus robustus, там же, 7265–7295 м [по: Виноградова, 1969, 1970]; *в* – новый род и вид из сем. Hexacrobilidae, желоб Волкано, 6330 м; *г* – Octacnemus sp. (сем. Octacnemidae), Курило-Камчатский желоб, 8185–8400 м

7000 м, остальные асцидии, видовая принадлежность которых уже определена, встречены не только в желобах, но не выходят за пределы абиссальной зоны или ее нижней подзоны. Описанная Н.Г. Виноградовой [1969а] очень своеобразная асцидия Situla pelliculosa (рис. 49), наиболее глубоководная из всех асцидий, найдена только в районе Курило-Камчатского желоба на глубинах от 5000 до 8400 м. В дальнейшем еще один вид этого рода был описан по нескольким нахождениям в Атлантическом океане в районе между Азорскими островами и Бискайским заливом на глубинах от 2115 до 4690 м [Monniot C., Monniot F., 1973], а затем еще два вида были найдены несколько глубже 5,5 км в районе Южно-Сандвичева желоба [Виноградова, 1975].

Figure 50. Large Single Ascidiae from Depth over 7 km in New Hebrides Trench
a. photo; b. graphic reconstruction [per: Lemche et al., 1976]

Representatives of the new Ascidiae genus and species from the family Hexacrobilidae[1] (not yet described) have been repeatedly found during Vityaz expeditions in the northern Pacific Ocean at depths about 5 km. Then, a sample of apparently the same species (see Fig. 49, C) was found in the Volcano trench at depth 6,3300 m [Beliaev, Mironov, 1977a, Table I, 10].

As indicated by Lemche et al., the large (up to 25 cm) single Ascidiae sitting on pedicels (Fig. 50) apparently belong to two species of the family Corellidae that were found on 32 bottom photographs in the New Britain trench from depths somewhat over 7,000 m. Their population density averaged 1 specimen per 30 m^2 [Lemche et al., 1976].

Based on the data of C. and F. Monniot [1978], the greatest number of deep-sea Ascidiea species in the World Ocean from depths over 2,000 m are confined to level 4-4.5 km in which 71 species of Ascidiea are found. Towards both the lower and higher depths, the number of deep-sea species diminishes rapidly, and for level 6-6.5 km C. and F. Monniot note only 8 species. As is apparent from the data in Table 25 of Appendix II, there are current grounds to consider that there are no less than 20 Ascidiea species living below 6 km.

OSTEICHTHYES

A bottom-dwelling fish was caught for the first time below 6 km by the Monaco expedition by the Princesse Alice research vessel in 1901 in the Zeleniy Mys trench. This fish was described in 1913 as belonging to a new genus and species Grimaldichthys profundissimus Roule (now converted to the genus Holomycteronus, family Ophidiidae). For half a century this remained the deepest sea finding. Only the

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[1] The Monniot husband/wife team in 1950 isolated 4 genera of single Ascidiae, including the genus Hexacrobylus, and a special class Sorberacea [Monniot et al., 1975]. However, they do not indicate which position this class occupies in the subtype Tunicata, what its relationship is to all the other Ascidiea, and whether the genera included in it belong to one or different families. Following the traditional system, I have therefore left the genus Hexacrobylus and the family Hexacrobyylidae in the Ascidiae class.

Danish Galathea expedition in 1950-1952 was able to find a fish at considerably greater depths, in theYavan trench at depth 7,160, a specimen of the same species was found

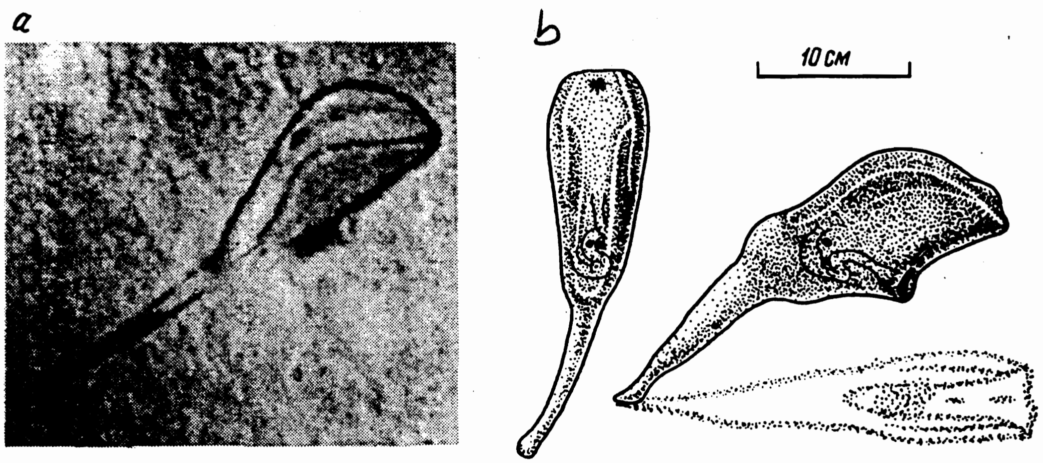

Рис. 50. Крупная одиночная асцидия с глубины более 7 км в Ново-Британском желобе
а – фото; *б* – графическая реконструкция [по: Lemche et al., 1976]

Представителей нового рода и вида асцидий из сем. Hexacrobilidae[1] (пока еще не описанных) неоднократно удавалось находить во время экспедиций на "Витязе" в северной части Тихого океана на глубинах около 5 км. В дальнейшем экземпляр, по-видимому, того же вида (см. рис. 49, *В*) был найден в желобе Волкано на глубине 6330 м [Беляев, Миронов, 1977а, табл. I, *10*].

Как указывают Лемхе с соавторами, крупные (до 25 см), сидящие на стебельке одиночные асцидии (рис. 50), видимо относящиеся к двум видам сем. Corellidae, были обнаружены на 32 фотографиях дна, полученных в Ново-Британском желобе с глубин несколько более 7000 м. Плотность их поселений составляла в среднем 1 экз. на 30 м^2 [Lemche et al., 1976].

По данным К. и Ф. Моннио [Monniot C., Monniot F., 1978], наибольшее число видов глубоководных асцидий Мирового океана, известных с глубин более 2000 м, приурочены к горизонту 4–4,5 км, в котором встречены асцидии 71 вида. Как в сторону уменьшения глубин, так и в сторону их увеличения число глубоководных видов быстро убывает, и для горизонта 6–6,5 км К. и Ф. Моннио отмечают лишь 8 видов. Как видно из данных, приведенных в табл. 25 Приложения II, в настоящее время есть основания считать, что глубже 6 км обитают, видимо, не менее 20 видов асцидий.

РЫБЫ – OSTEICHTHYES

Впервые несколько глубже 6 км придонная рыба была поймана экспедицией Монако на э/с "Принцесса Алиса" в 1901 г. в котловине Зеленого Мыса. Эта рыба была в 1913 г. описана как относящаяся к новому роду и виду Grimaldichthys profundissimus Roule (теперь переведен в род Holcomycteronus, сем. Ophidiidae). В течение половины столетия это нахождение оставалось самым глубоководным. Лишь датской экспедиции на "Галатее" 1950–1952 гг. удалось обнаружить рыб на значительно больших глубинах – в Яванском желобе на глубине 7160 м был пойман экземпляр того же

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[1] Супруги Моннио в 1975 г. выделили 4 рода одиночных асцидий, в том числе и род Hexacrobylus, в особый класс Sorberacea [Monniot et al., 1975]. Однако они не указывают, какое положение занимает этот класс в подтипе Tunicata, каково его родство со всеми остальными асцидиями (класс Ascidiae) и относятся ли включаемые в него роды к одному или разным семействам. Поэтому пока я, следуя традиционной системе, оставляю род Hexacrobylus и сем. Hexacrobylidae в классе Ascidiae.

as in the Zeleniy Mys trough, and at depth about 6,700 m in the Kermadec trench a representative of the family Liparidae. Both of these findings were only described in detail in 1964 [Nielsen, 1964]. Several specimens of two Liparidae were caught in 1953-1957 by Vityaz expeditions in the Kuril-Kamchatka and Japan trenches, including in the latter all the way to depth 7,587 m. Finally, in 1970 the American expedition on the J. E. Pilsbury caught yet another representative of the family Ophidiidae in the Puerto Rico trench at depth 8,370 m that is now the deepest depth of catching the fish.

Appendix II, Table 26, gives a list of all the fish species that were caught at depths over 6,000 m. There are currently 7 known species. All of them are Teleostei of two orders, 3 specieis of Liparidae from the order Scorpaneiformers and 4 species of two families of the order Gadiformes.

All three Liparidae species are endemic for depths over 6 km and have a narrow-local dissemination in one or two neighboring trenches of the Pacific Ocean. These three species are closely related and were initially [Andriashev, 1955; Nielsen, 1964] classified as one genus Careproctus. Only further was the species from the Kermadec trench isolated into a special genus Notoliparis, while the northern Pacific Ocean species (suborder Pseudoliparis) also possibly deserve separation into an independent genus (see: [Andriashev, 1978, p. 152]). It is important that another two Notoliparis species were described from later collections of Soviet expeditions from the Antarctic and Subantarctic waters, and the fish of both species were caught at depths about 5,400-5,500 m., i.e., only 500-600 m above the formal boundary of the ultra-abyssal zone. One of these species, N. kurchatovi Andriashev was described near the yet unstudied South Orkney trench, and in the same trawling haul there were also some invertebrates, typical for the trench ultra-abyssal fauna. Andriashev considers it likely that this species also dwells in the South Sandwich trench [Andriashev, 1975]. The second of these species, N. macquariensis Andriashev, has been described from the sub-Anatarctic Macquarie trench whose greatest depth is about 5.5 km [Andriashev, 1978]. It is quite possible that the latter species dwells and is located even further to the south of the Hjort trench with maximum depth about 6,700 m. Thus, the Pseudoliparis species are endemic for depths over 6,000 m and for trenches of the northwest Pacific Ocean, and all known Notoliparis species are disseminated to the south of 35° s. l. and only in the depth range from 5,400 to 6,770 m.

In contrast to the Liparidae, two of the Ophidiidae representatives that are known from depths over 6,000 m, Abyssobrotula galatheae and Holcomycteronus profundissimus, are also widespread at lower depths in the Atlantic, Indian and Pacific Oceans. The first of these species is known from 11 findings at depths from 2,330 to 8,370 m, the second from 5 findings at depths from 5,180 m to 7,160 m. The dissemination of the third ultra-abyssal Ophiuroidea species, Leucicorus atlanticus, is limited to the western Atlantic Ocean from which it is known from 7 findings (5 in the Cayman trench, and one in the Yucatan trough of the Caribbean Sea and in the Puerto-Rico trench area) from depths 4,580 to 6,800 m.

It is well known that some representatives of another family of the order Gadiformes, Macrouridae, are common at abyssal depths and conduct a bottom-dewelling lifestyle. Okutani [1982] thus reports that during numerous benthic trawlings by a two-meter beam-trawl in the western part of the northwest Pacific Ocean trench in 1977-1980 by the Japanese vessel Soyo-Maru the only often found fish that was not defined to species was a representative of the genus Coryphaenoides (Coryphaenoid fish), that apparently is fairly common on the ocean abyssal floor. This same publication makes the first report of catching one specimen of Coryphaenoides by a long-lined crab-basket set at depth 6,180 m, a direct proof that these fish swim in direct proximity to the bottom, as noted by Okutani.

Information has also been published that bottom-dwelling fish have been observed from

Figure 51. Fish Found Below 6 km
A. Abyssobrotula galatheae [per: Nielsen, 1977]; B. Halcomycteronus profundissimus [per: Nielsen, 1964]; C. Leuicocorus atlanticus [per: Nielsen, 1975]; D. Careproctus (Pseudoliparis) ambylstomposis [per: Andriashev, 1955]; E. Notoliparis kermadecensis [per: Nielsen, 1964]

bathyscaphes. It is mentioned in brief reports from descents of the French Archimede bathyscaphe to ultra-abyssal depths of the northwest Pacific Ocean trench [Anonym., 1962, 1963] that the observers in the bathyscaphe on August 12, 1962 saw several fish on the floor of the Izu-Bonin trench at depth about 9,220 m. When Archimede descended in the summer of 1967 in the Japan trench, a fish similar to Careproctus was noted at depth 7,220 m [Laubier, 1985]. This observation agrees well with the catch by the Vityaz expedition in April of the same year at a somewhat lower depth of the Japan trench (about 7,600 m) of a fish that belongs to the new species of the Careproctus genus.

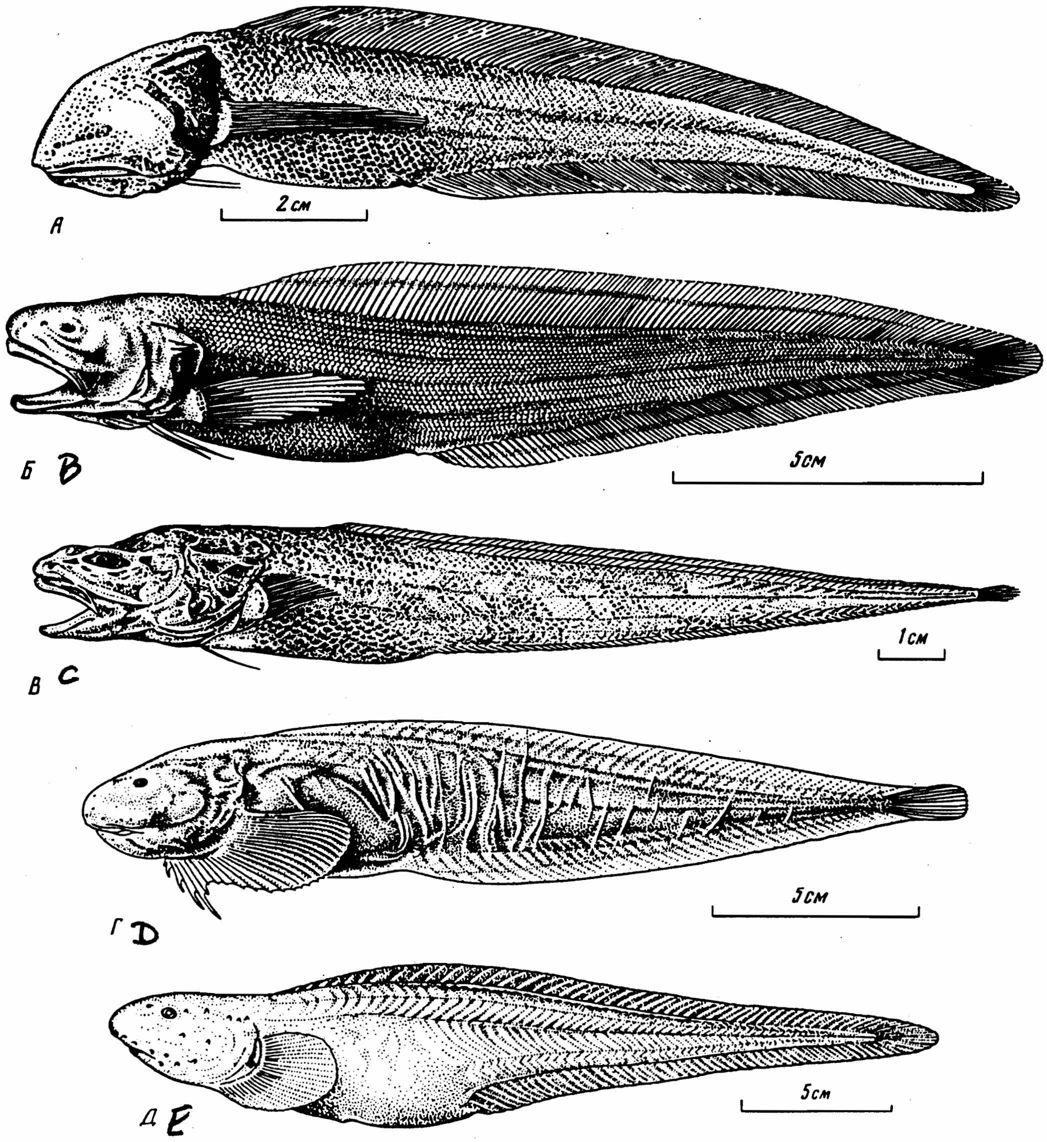


Рис. 51. Рыбы, найденные глубже 6 км
А – Abyssobrotula galatheae [по: Nielsen, 1977]; Б – Halcomycteronus profundissimus [по: Nielsen, 1964]; В – Leucicorus atlanticus [по: Нильсен, 1975]; Г – Careproctus (Pseudoliparis) amblystomopsis [по: Андрияшев, 1955]; Д – Notoliparis kermadecensis [по: Nielsen, 1964]

батискафов. В кратких сообщениях о спусках французского батискафа "Архимед" в ультраабиссальные глубины желобов северо-западной части Тихого океана [Anonym, 1962, 1963] упомянуто, что находившиеся в батискафе наблюдатели 12 августа 1962 г. видели нескольких рыб у дна Идзу-Бонинского желоба на глубине около 9220 м. При погружении "Архимеда" летом 1967 г. в Японском желобе рыба, похожая на Careproctus, была замечена на глубине 7220 м [Laubier, 1985]. Это наблюдение прекрасно согласуется с поимкой экспедицией на "Витязе" в апреле того же года на несколько большей глубине Японского желоба (около 7600 м) рыбы, относящейся к новому виду рода Careproctus.

Fish were also successfully observed in the Puerto-Rico trench during descents of the same Archimede bathyscaphe in May-June of 1964. One fish was noted near the floor during a deeper submersion of the bathyscaphe at depth 8,300 m [Wolff, 1964; Peres, 1965]. J. M. Peres cites more detailed information about the bottom-dwelling fish that he observed during submersions to depths 7,250 m. The bathyscaphe floated at this depth above the bottom for about one mile, and during this time Peres counted about 200 specimens of small fish similar to Careproctus, and also saw three fish of two other species [Peres, 1965].

Unfortunately, no photographs were made in any of these instances of the fish that would allow a reliable determination. However, a catch of Abyssobrotula galatheae in the Puerto-Rico trench at approximately the same depth at which the fish was observed from the bathyscaphe is a confirmation of these observations. It is quite likely that the fish will be caught later at even greater depths. The report of Jacque Piccard [1960; Piccard, Dietz, 1963] that during a descent of the Trieste bathyscaphe to the bottom of the Mariana trench on January 23, 1960, he and his companion, D. Walsh, through the porthole at depth 10,912 m on the floor saw a flat flounder is apparently erroneous. It is more likely that they assumed that the fish was another animal, most likely a large Holothurioidea [Wolff, 1961].

It is interesting that when bait is placed on the ocean floor at abyssal depths and is photographed, the resulting photographs show that quite a few fish of several species almost always gather at the bait, Macruridae, Brotulidae, Zoarcidae, and Liparidae [Hesler et al., 1978]. These fish clusters at the benthic bait are easily visible, for example, on the photographs at depth 5,856 m in the northwest Pacific Ocean (34°03' n.l., 163°59' e.l) [Dayton, Hessler, 1972] and at depth 5,861 m on the edge of the Philippine trench (9°53' n.l., 127°43.8', e.l.) [Hessler et al., 1978]. The authors of the latter publication have also noted similar fish clusters at benthic bait in the abyssal zone near the Chile trench (see Fig. 36). These authors, however, make special note that they never noted fish gathered near bait lowered to trench ultra-abyssal depths (6,717 and 7,196 m in the Chile trench, near 9,600 m in various parts of the Philippine trench, and 10,500 m in the Mariana). Insofar as these observations were made not only at the maximum depths (9,600-10,500 m) where the fish possibly do not penetrate at all, but also at lower depths, where the possible existence of the fish has been proven, it has to be hypothesized that although the fish live in the ultra-abyssal trench depths, there are very few of them and their populations are very sparse. Illustrations of ultra-abyssal fish are given in Fig. 5.1.

Chapter 5.

GENERAL CHARACTERISTICS OF THE COMPOSITION OF THE TRENCH BENTHIC FAUNA

It is apparent from the data cited in the previous chapter that more or less numerous representatives of the overwhelming majority of the large taxonomic groups have now been found in the benthic fauna populating the depth over 6 km of the free-moving marine organisms living on the floor or near the bottom.

In addition to bacteria and Protozoa (Foraminefera, Xenophora) below 6 km representatives were found of 17 types and 37 classes that belong to approximately 210 families and more than 400 taxons of the genus rank (several genera represented by two suborders). There are approximately species definitions already known for 720 forms, but some of these species have not yet been described. Of these 720 taxons, 660 are species rank. benthic or bottom-dwelling species, 58 are true pelagic, not related to the bottom (Hydromedusae, suborder Calanoida from the Copepoda, family Halocypridae from the Ostracoda, suborder Hyperiidea and some representatives of Gammaridea, mainly Hyperiopdsidae from the Amphipoda).

The number of species that are known from different trenches is indicated in Table 8 (the total number of species in this table is less than the formal sum for the trenches since many species are found in several trenches).

GROUPS ABSENT AT DEPTHS BELOW 6 km

Of the free-living marine benthic animals none of the Protozoa have been found below 6 km, Infusoria, and of the Metazoa, Calcispongia, Ctenophora, Kinorhyncha, Kamptozoa Merostomata (order Xiphozura), Phoronoidea, Pterobranchia and Acrania, as well as benthic Decapoda (suborder Reptantia).

As for the Infusoria and Kinorhyncha, it is difficult to say whether or not they really penetrated to depths over 6 km or were not found here because it is necessary to use special collection methods that have only been to be used in deep-sea research to find these extremely small animals that have a very delicate structure. Until comparatively recently, these groups were not known at all from great depths and only in 1966 was Kinorhyncha found at depths to 4,690 [Thiel, 1966].

From depths over 6 km some groups that are now detected at these depths were also not known comparatively recently (Turbellaria, Oligochaeta, Gastrotricha, Tardigrada, marine Acarina, shrimp, Brachyopoda).

Benthic Ctenophora, Kamptozoa, Xiphosura, Phoronidea, Pterobranchia and Branchiostoma, are a fairly small and exclusively or predominantly shoal group. The absence of animals from these groups below 6,000 m is therefore not unexpected: apparently they are really incapable of penetrating to these depths. Among the Calcispongia and benthic Decapoda only a small percentage is species adapated to life in the abyssal, and none have been found below 5,200 m. It is possible that these two groups are the first in an essentially continuous series of those selected from the fauna under the influence of pressure as the maximum depths are reached.

There is currently no possibility of making a specific comparison of the species diversity of the abyssal and hadal fauna since there is no summary information about the number of types of abyssal fauna based on the numerous data of the last decade regarding the very diverse fauna in the hydrothermal outcroppings, and apparently, the very unique fauna of the underwater ridges and numerous underwater mountains of which a special study has only been started recently. One can only state that the hadal fauna as a whole is at least 3-4 times lower in diversity to the abyssal fauna.

ENDEMISM

The degree of species endemism for the entire benthic and bottom-dwelling fauna of depths over 6 km averages 56%. Endemism for the real pelagic fauna is somewhat lower, averaging 41%. However, as indicated in Chapter 4 for individual groups of animals (see Figs. 28-32, 40-44) and as is clear from Fig. 52, the total degree of endemism for all benthic Metazoa increases naturally with depth. Depths 6-7 km as already noted repeatedly are transitional between the abyssal and hadal, and are characterized by the least degree of fauna endemism compared to the deeper levels. The mean degree of species endemism for level 6-6.5 km is 26%.

Figure 52. Vertical Dissemination of Benthic and Bottom-Dwelling Metazoa Known from Depths over 6 km (A) and Change with Depth in Number of Species (1) and Percentage of Endemics (2)- (B)

Figure 53. Change in Species Endemism of Benthic Fauna (%) with Depth in Trenches of Temperate (A) and Tropical (B) Latitudes of Pacific and Indian Oceans
Numbers in parentheses are the number of species analyses for each kilometric level

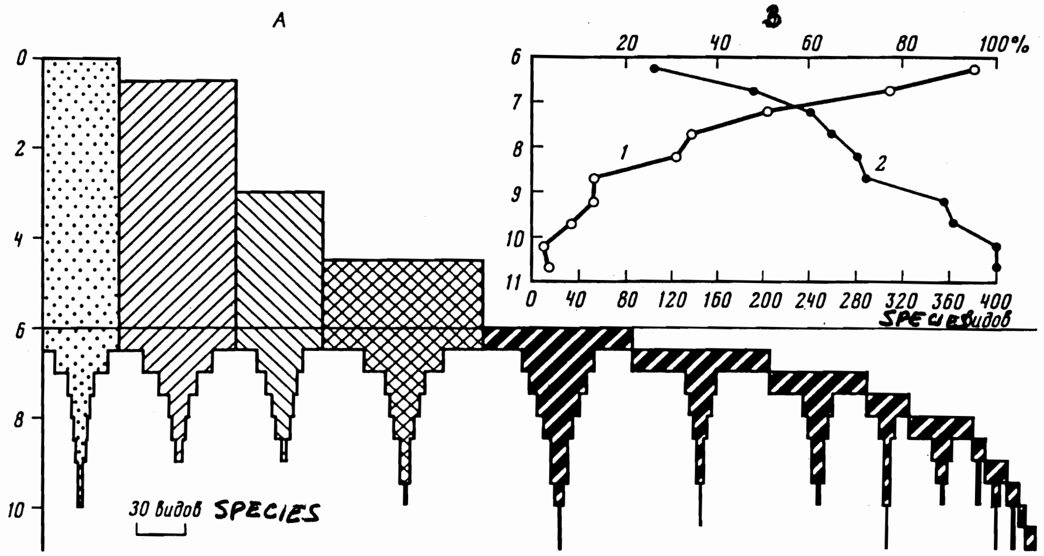
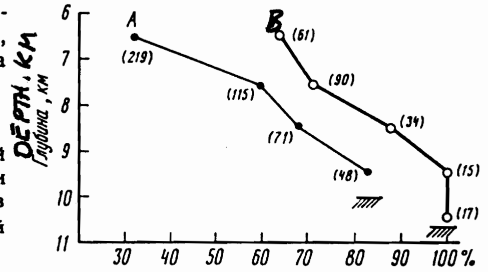


Рис. 52. Вертикальное распространение донных и придонных Metazoa, известных с глубин более 6 км (*А*), и изменение с глубиной числа видов (*1*) и процента эндемиков (*2*) – (*Б*)

Рис. 53. Изменение видового эндемизма донной фауны (%) с глубиной в желобах умеренных (*А*) и тропических (*Б*) широт Тихого и Индийского океанов

Числа в скобках – количество видовых определений для каждого километрового горизонта



Естественно поэтому, что наименьшие показатели эндемизма (от 20 до 28%) характерны для фауны желобов (Перуанский, Хьорт) и котловин, траловые ловы в которых проводились лишь в горизонте 6–6,5 км (табл. 8). Наибольший процент эндемиков (86–100%) свойствен желобам, в которых и средняя глубина ловов была наибольшей (Тонга, Марианский, Филиппинский). Для всех остальных желобов эндемизм их фауны колеблется от 37 до 81%, причем эти различия не согласуются с различиями в средней глубине ловов.

При анализе данных табл. 8 бросается в глаза различие между желобами умеренных и тропических широт. Для проверки того, насколько закономерны эти различия, я провел сравнение изменения степени эндемизма по глубине для двух групп желобов, глубины которых превышают 7 км. В первую группу были включены все желоба, расположенные в умеренных широтах: Алеутский, Курило-Камчатский, Японский, Идзу-Бонинский, Кермадек и Чилийский (65 тралений на глубинах до 10 км) – со средними показателями эндемизма от 42 до 59%. Поскольку все эти желоба расположены в Тихом океане, в сравниваемую группу желобов тропических широт были включены также только тихоокеанские желоба – Волкано, Марианский, Яп, Палау, Рюкю, Филиппинский, Бугенвильский, Ново-Гебридский, Тонга, а также находящийся в непосредственной близости к Тихому океану Яванский желоб (55 тралений на глубинах до 10 730 м) со средними показателями эндемизма от 54 до 100%. Из этой группы был умышленно исключен желоб Банда, характеризующийся среди желобов тропических широт наименьшей степенью эндемизма его фауны (43%), что, возможно, указывает на его относительную молодость (см.: [Беляев, 1966б, 1972;

It is therefore natural that the least endemism indicators (from 20 to 28%) are characteristic for the fauna of trenches (Peru, Hjort) and troughs in which trawling catches were only made in the 6-6.5 km level (Table 8). The greatest percentage of endemics (86-100%) is inherent to the trenches in which the mean depth of the hauls was the greatest (Tonga, Mariana, Philippine). The endemism for all the other trenches fluctuated from 37 to 81%, and these differences do not agree with the differences in the mean depth of the catches.

Analysis of the Table 8 data indicates a remarkable difference between the trenches in the temperate and tropical latitudes. In order to verify how natural these differences are, I compared the changes in the degree of endemism over depth for two groups of trenches with depth over 7 km. The first group included all the trenches in the temperate latitudes: Aleutian, Kuril-Kamchatka, Japan, Izu-Bonin, Kermadec and Chile (65 trawlings at depths up to 10 km) with mean endemism indicators from 42 to 59%. Insofar as all of these trenches are located in the Pacific Ocean, only Pacific Ocean trenches were included in the compared group of tropical latitude trenches, Volcano, Mariana, Yap, Palau, Ryukyu, Philippine, Bougainville, New Hebrides and Tonga, as well as the Yavan trench which is in direct proximity to the Pacific Ocean (55 trawlings at depths to 10,730 m) with mean endemism indicators from 54 to 100%. The Banda trench was intentionally omitted from this group because it is characterized among the tropical latitude trenches with the least degree of endemism of its fauna (43%), which possibly indicates its relative young age (see: [Beliaev, 1966b, 1972;

TABLE 8.
NUMBER OF SPECIES OF BENTHIC AND BOTTOM-DWELLING METAZOA KNOWN FROM VARIOUS TRENCHES FROM DEPTHS OVER 6 km AND DEGREE OF ENDEMISM, %

Key:
1. Trench
2. Number of trawling hauls
3. Mean haul depth, m
4. Number of species analyses
5. % of endemic ultra-abyssal species
6. Approximate number of undefined species
7. Aleutian
8. Kuril-Kamchatka
9. Japan
10. Izu-Bonin
11. Volcano
12. Mariana

13. Yap
14. Palau
15. Philippine
16. Ryukyu
17. Bougainville
18. New Hebrides
19. Tonga
20. Kermadec
21. Peru
22. Chile
23. Banda
24. Hjort
25. Yavan
26. South Sandwich
27. Romanche
28. Puerto-Rico
29. Cayman
30. Pacific Ocean troughs
31. Atlantic Ocean troughs
32. Total
33. About

Belyaev, 1972]). The results of this comparison are shown in Fig. 53, from which it is evident that a significantly greater species fauna endemism is inherent to the tropical latitude trenches than to the temperate latitude trenches.

The mean indicators of fauna endemisms of a certain trench, in addition to the depth, is also affected to a certain measure by the degree of study of the various groups of animals, insofar as they have an inherent varying degree of endemism (Table 9), in other words, a varying rate of isolation from the less deep-sea fauna, apparently due to varying rates of evolution (differences in the rate of species differentiation) at ultra-abyssal depths. However, the differences in the population composition could hardly be the reason for such a distinct difference between the endemism in the temperate and tropical latitude trenches. It is still unclear how to explain this difference.

The low degree of fauna endemism in the South Sandwich trench (37%) may be explained by its location in the cold sub-Antarctic region which is generally characterized by a rise in deep-sea animals to shallower depths that are usually not characteristic for them.

Trench fauna endemism at the genus taxon level (see Table 9) fluctuates in different classification groups from 0 to 26%, averaging 10%. The list of endemic genera is given in Table 10.

Таблица 8

Число видов многоклеточных донных и придонных животных, известных из разных желобов с глубин более 6 км и степень эндемизма, %

Желоб 1	Число учтенных траловых ловов 2	Средняя глубина лова, м 3	Число видовых определений 4	% эндемичных ультраабиссальных видов 5	Ориентировочное число не определенных видов 6
Алеутский 7	7	7018	59	42	25
Курило-Камчатский 8	26	7791	189	50	43
Японский 9	11	6971	98	53	38
Идзу-Бонинский 10	8	7934	40	48	24
Волкано 11	4	7311	13	54	17
Марианский 12	9	8994	12	100	12
Яп 13	3	7705	16	81	10
Палау 14	2	7545	13	77	22
Филиппинский 15	14	8635	29	86	27
Рюкю 16	3	6973	14	72	10
Бугенвильский 17	5	8409	34	71	21
Ново-Гебридский 18	1	6750	5	60	17
Тонга 19	4	9308	12	100	5
Кермадек 20	8	7690	74	59	15
Перуанский 21	8	6165	43	23	22
Чилийский 22	2	7360	4	50	2
Банда 23	5	7115	30	43	6
Хьорт 24	3	6303	5	20	2
Яванский 25	6	6813	38	71	12
Южно-Сандвичев 26	5	7201	43	37	20
Романш 27	5	7183	10	60	12
Пуэрто-Рико 28	5	7504	26	50	6
Кайман 29	7	6512	17	47	4
Котловины Тихого 30 океана	9	6126	85	28	19
Котловины Атлантического океана 31	3	33 Около 6000	25	20	19
Всего 32	164	7157	660	56,4%	300

Belyaev, 1972]). Результаты этого сравнения приведены на рис. 53, из которого видно, что желобам тропических широт свойствен на всех глубинах значительно больший видовой эндемизм их фауны, чем желобам умеренных широт.

Кроме глубины, на средние показатели степени эндемизма фауны того или иного желоба в какой-то мере влияет и степень изученности разных групп животных, поскольку им свойственна разная степень эндемизма (табл. 9), иначе говоря различная скорость обособления от менее глубоководной фауны, видимо обусловленная разными темпами эволюции (различиями в скорости видовой дифференциации) на ультраабиссальных глубинах. Однако различия в составе животного населения едва ли могут быть причиной столь четкого различия между эндемизмом в желобах умеренных и тропических широт. Чем объясняется это различие, пока неясно.

Малая степень эндемизма фауны Южно-Сандвичева желоба (37%), возможно, объясняется его приуроченностью к холодному субантарктическому району, для которого вообще характерен подъем глубоководных животных на обычно несвойственные им меньшие глубины.

Эндемизм фауны желобов на уровне таксонов родового ранга (см. табл. 9) колеблется в разных систематических группах от 0 до 26%, а в среднем составляет 10%. Список эндемичных родов приведен в табл. 10.

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TABLE 9.
SPECIES AND GENUS ENDEMISM OF THE MAIN GROUPS OF BENTHIC METAZOA DWELLING AT DEPTHS OVER 6 km

Key:
1. Group
2. Species taxons
3. Number of analyses
4. % of endemics
5. Genus taxons
6. Number of analyses
7. % of endemics
8. Other
9. Other groups
10. Summary data

* Without consideration for the purely plankton genera and genera in groups only defined to the family level.

Таблица 9

Видовой и родовой эндемизм основных групп донных многоклеточных животных, обитающих на глубинах более 6 км

Группа 1	Таксоны видового ранга 2		Таксоны родового ранга 5	
	Число определений 3	% эндемиков 4	Число определений 6	% эндемиков 7
Polychaeta	73	40	50	14
Echiuroidea	13	30	10	0
Tanaidacea	53	40	15	7
Isopoda	122	63	34	9
Amphipoda	35	78	28	11
Gastropoda	56	68	41	26
Bivalvia	47	68	33	15
Holothurioidea	56	69	20	10
Прочие Echinodermata 8	53	49	30	7
Pogonophora	29	76	10	10
Прочие группы 9	123	43	93	9
Суммарные данные 10	660	56,4	364*	10

*Без учета чисто планктонных родов и родов в группах, определенных лишь до семейства.

Таблица 10

Таксоны родового ранга, эндемичные для глубин более 6 км

Род 1	2 Распространение		Число видов — нахождений 5
	Желоб 3	Глубина, м 4	
1	2	3	4
Hydroidea		6	
*Voragonema Naumov П P	КК	Лов 8700–6800	1–1
Actiniaria			
*Hadalanthus Carlgren	Кер	6660–6770	1–1
Polychaeta			
Bathyedithia Pettibone	AL RYU PLP Ал, Рюкю, Фил	6810–7880	1–4
Bathykermadeka Pettibone	JAP YAP Япон, Яп, Кер, B PLP Бан, Фил?	6660–8720 (10210?)	1–8
Bathykurila Pettibone	JAP PLP КК, Япон, Фил	6600–8400	1–4
*Bathilevensteinia Pettibone	Тон TON	9735–9875	1–1
*Bathimariana Levenstein	Рюкю RYU	7440–7450	1–1
Macellicephaloides Uschakov	КК, Япон, JAP M Мар, ЮС SS	6150–10710	8–18
Vitjazia Uschakov	КК, Япон JAP	6150–8100	1–6
Copepoda			
Puchinia Vyshkvartzeva П P	КК	8500–6000	1–2
*Herdmaniopsis Brotzkaja	С-з котл То NW trough	6076	1–1
Isopoda			
*Arybalurops Gamô	Япон JAP	6380–6450	1–1
Austroniscoides Birstein	Буг BG	6920–9043	1–3
*Nannoniscidae gen.n.Wolff	Кайман CA	6800	1–1
*Nannoniscidae gen. n. Wolff	ПР PR	8330	1–1

Таблица 10 (окончание)

1	2	3	4
Amphipoda	PLP TON		
Bathyschraderia Dahl	Фил, Кер, Тон	6960–9990	2–11
Metaceradocoides Birst. et Vinogradova	JAP КК, Япон, ИБ, IB M Мар, Яп Y	6600–8345	1–9
*Steleutera Barnard	Пер P	6324–6328	1–1
*Eusiridae gen. n.(?) Dahl	Кер	6960–7000	1–1
Gastropoda	N-W TROUGH		
Abyssobela Kantor et Sysoev	С-з котл То	6096–6127	1–2
Aenigmabonus Moskalev	КК	6090–8120	1–2
Bonus Moskalev	КК, Тон TON	8240–9530	1–6
Callilonchа Lus	КК, ИБ IB	6770–8120	2–2
Caymanabyssia Moskalev	Кайман CA	6740–6800	1–2
Kurilohadalia Sysoev et Kantor	КК, Япон JAP	6156–8430	2–9
*Paracallilonchа Lus	КК	8035–8120	1–1
*Tuskaroria Sysoev	КК N-W TROUGH	7210–7230	1–1
Vitjazinella Sysoev	КК, С-з котл То	6090–6135	1–2
Bivalvia			
Parayoldiella Filatova			
7 Подрод Intercalaria Filat. et Schileico	JAP КК, Япон	7350–7710	1–4
7 Подрод Parayoldiella s. str.	IB VOLC КК, ИБ, Волк, JAP PL Мар, Яп, Пал, PLP Фил, ЮС SS	6330–10190	7–23
7 Подрод Polycordia (Angustebranchia) Ivanova	КК	8060–9335	6–11
Nuculanidae gen. n. Filatova	TON Тон, Кер	8928–10687	1–2
*Nuculanidae gen. n. Filatova	Яв Y	6820–6850	1–1
Asteroidea	RYU PLP		
Lethmaster Belyaev	Рюкю, Фил	6460–7880	1–5
Ophiuroidea	AL JAP		
Abyssura Bel. et Litvinova	Ал, КК, Япон	6156–7295	1–5
Holothurioidea	NB BG NH		
Hadalothuria Hansen	НБ, Буг, НГ, КК	6758–9530	1 (2?) –4 + + фото 8
*Psychropotidae gen. n. Belyaev	КК	9170–9335	1–1
Pogonophora			
*Cyclobrachia Ivanov	Буг BG	7974–8006	1–1
Osteichthyes	JAP		
7 Подрод Careproctus (Pseudoliparis) Andriashev	КК, Япон	6156–7587	2–4

*Монотипические роды, известные по одному нахождению.

Примечание. П – пелагические роды; объяснение сокращенных названий желобов см. в Приложении.

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Three endemic subfamilies for depths over 6 km are known from the family taxon rank. Two of them were isolated [Pettibone, 1976] in the Polynoidae family from Polychaeta, Macellicephaloidinae and Bathyedithinae, and one in the Porcellanasteridae family from Asteroidea [Beliaev, 1985a], Lethmasterinae. Additionally, in different groups there are at least 10 known genera disseminated not only in the trenches, but endemic for depths over 5 or 5.5 km at which they dwell near the corresponding trenches. Two families have this same dissemination, Gigantapseudidae Kud.-Past. from Tanaidacea (5,460-7,880 m in the Philippine trench region) and Vemidae Moskalev et al. from Monoplacophora (5,607-6,489 m in the Peru trench region).

Chapter 6
VERTICAL DISSEMINATION

DEGREE OF EURYBATHICITY

It was apparent from the previous chapters that the ultra-abyssal benthic fauna are not unique in the entire depth range from 6 to 11 km and could reveal some laws governing its change as the depth increases. The total number of species in all taxonomic groups of animals diminishes with depth, while the percentage of species endemic for the zone as a whole increases. As the depth rises, there is also a change in the species composition. The species that dwell not only in the ultra-abyssal, but also in the overlying zones (abyssal, bathyal, sublittoral) generally do not penetrate below the upper ultra-abyssal levels (see Fig. 52).

The extremely eurybathic species with vertical range from sublittoral or bathyal to ultra-abyssal comprise only 19% of the total number of species living in the trenches. The total range of vertical dissemination of these species is 5-6 km or even more, but generally their most shallow and the deepest populations are separated by broad hiatuses (e.g., three species of Teredo, Pogonophora Siboglinum caulleryi, some Polychaetae, Sipunculoidea, Tanaidacea from the Crustacea, etc.). This dissemination in various instances may apparently be explained by different reasons. In some instances it is apparently a matter that a certain species group needs a thorough systematic revision which could mean (as has already happened) that the species which are now considered widespread and eurybathic, really are a combination of several species with more local dissemination. It should also be taken into account that the approach to determining the species volume could differ severely among various researchers. In other instances, we are likely dealing with species that have penetrated the trench depths comparatively recently; the species differentiation of isolated populations living at different depths in these instances may not go beyond a biochemical or physiological level, and not reach morphological differences[1], or these differences are so slight that they may be revealed only in a reliable comparative study of variability within different populations, which, unfortunately, is most often impossible for deep-sea species due to the lack of material. Finally, as mentioned in Chapter 4, in some instances, we are dealing with so-called "guest" species that are capable in the adult state of existing temporarily at great depths (e.g., some Teredo), but are incapable of reproducing at these depths.

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[1] Hessler et al. [1978] assume a similar explanation regarding Amphipoda Hirondellea gigas that are widespread in many trenches at depths 7-10.5 km, but are still unknown beyond the trenches at abyssal depths. No morphological differences have been noted between the representatives of different trench populations.

As for the abyssal-hadal species, more than half of them are species with vertical dissemination range from less than 2 or 1 km. Stenobathic species dominate to an even greater degree among the ultra-abyssal endemics. It is true that almost 65% of the endemics are now known only from a single typical finding (although often fairly numerous specimens have been described). However, repeated findings usually only slightly increase their dissemination range. There are currently 130 known endemic species from more than one finding. They are distributed as follows according to the degree of eurybathic nature

Range of vertical dissemination, m	% of species	Range of vertical dissemination, m	% of species
Less than 500	22	1,500-2,000	16
500-1,000	24	2,000-3,000	11
1,000-1,500	22	Over 3,000	5

Thus, only 1 species of Holothurioidea, Prototrochus bruuni, has a vertical range over 4 km (6,487-10,687 m), but this species is clearly combined and needs revision. The other most eurybathic species belong to the near-bottom Amphipoda that are capable of swimming well even in the water mass.

VERTICAL ZONALITY

Thus, among the species whose vertical dissemination data may be considered more or less reliable (abyssal-hadal species and endemics in trenches known from more than one finding), the range of vertical distribution for 85% does not exceed 3 km, and for 66% 1 or 2 km. This determines the vertical change in species composition and the existence of vertical zonality within the hadal zone. Back in 1966 [Beliaev, 1966a, b] I suggested dividing this zone into three subzones: upper, 6-7 km (transitional between abyssal and hadal), middle, 7-8.5 km, and lower, below 8.5 km. The newly gathered data have changed little in this respect. Perhaps the transitional nature of the 6-7 km depths, and especially the 6-6.5 km level is only clearer. It may be additionally noted that the boundaries of these subzones to a certain degree are conditional and could be shifted slightly in different trenches, and especially for animals of different taxonomic groups. It is not excluded that the boundary of the middle and lower subzones could sometimes pass somewhere between 8.5 and 9 km.

Table 11 gives information about the greatest depths for finding animals of different classification groups (rank of classes-orders) that are known from the deep-sea trenches. These same data, summarized for five-hundred meter levels are given in Fig. 54. It is apparent from the figure that within the ultra-abyssal zone not only does the number of species decrease with depth, as previously shown, but also the number of large taxonomic groups. The clearly pronounced stages in the fauna of large groups that drop out of the composition as the depth increases determines the uniqueness of the fauna of different subzones. Representatives of 55 major groups are known from the upper level 6-6.5 km, and representatives of only 8 such groups belonging to 7 classes (possibly, also representatives of yet another, possibly eighth class, Gastropoda, but only empty shells of these mollusks have been found at these depths) penetrate to maximum depths over 10.5 km. Residue from the fauna of major taxons are more extremely pronounced in the level 8-8.5 km, which agrees well with the confinement to 8.5 km fo the boundary between the middle and lower hadal subzones.

Polychaeta and Holothurioidea from the Metazoa found in almost all the hauls are foremost in frequency of encounter for all the subzones.

Figure 54. Maximum Depths of Penetration of Different Groups of Animals, Summarized at 500-meter Levels

Key:

Paste in key from original text

Then in frequency of encounter in the entire ultra-abyssal zone follow (in decreasing order), Bivalvia, Actiniea, Isopoda, Amphipoda and Gastropoda. All of these zones are also characteristic for Echiuroidea, Crinoidea and Pogonophora.

In the upper subzone, and especially in its upper 500-meter level, in addition to the groups that are characteristic for all subzones, Ophiuroidea, Asteroidea, Spongia and Ascidia are very common. The importance of these groups diminishes sharply at greater depths.

Differences in the fauna of the three subzones are also revealed in a comparison of the quantitative abundance (population) of benthic animals of different taxonomic groups (fig. 55). It is clearly seen from this figure that representatives of only two classes, Holothurioidea and Bivalvia, dominate in the ultra-abyssal fauna as a whole, and especially in its middle and lower subzones. If one takes into consideration the comparatively large dimensions of the Holothurioidea, then combined with their high population, this

PASTE IN KEY

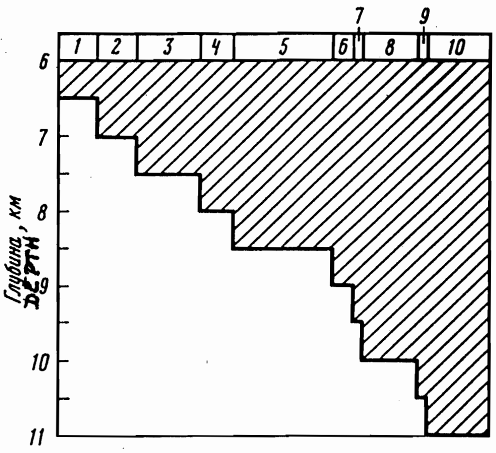

Рис. 54. Максимальные глубины проникновения разных групп животных, суммированные по 500-метровым горизонтам

1 — Alcyonaria, Madreporaria, Monoplacophora, Septtibranchia, Decapoda Natantia; *2* — Hyalospongia, Pennatularia, Tardigrada, Sipuncula, Acariformes; *3* — Turbellaria, Nemertini, Oligochaeta, Hirudinea, Pantopoda, Loricata, Scaphopoda, Echinoidea; *4* — Priapulida, Cirripedia, Cumacea, Opisthobranchia, Chaetognatha; *5* — Xenophiophoria, Hydroidea, Gorgonaria, Anthipatharia, Ostracoda, Pectinibranchia, Cephalapoda, Ophiuroidea, Bryozoa, Brachiopoda, Enteropneusta, Ascidiae, Osteichthyes; *6* — Mysidacea, Aplacophora, Lophenteropneusta; *7* — Tanaidacea; *8* — Demospongia, Scyphozoa, Harpacticoida, Cyclobranchia, Crinoidea, Asteroidea, Pogonophora; *9* — Echiuroidea; *10* — Foraminifera, Actiniaria, Nematoda, Polychaeta, Isopoda, Amphipoda, Bivalvia, Gastropoda (?), Holothurioidea

частоте встречаемости во всей ультраабиссальной зоне следуют (в порядке убывания) двустворчатые моллюски, актинии, изоподы, амфиподы, брюхоногие моллюски. Для всей зоны характерны также эхиуриды, стебельчатые морские лилии и погонофоры.

В верхней подзоне, и особенно в ее верхнем пятисотметровом горизонте, наряду с группами, характерными для всех подзон, очень обычны офиуры, морские звезды, губки, асцидии. На бóльших глубинах значение этих групп резко убывает.

Различия в фауне трех подзон выявляются и при сравнении количественного обилия (численности) донных животных разных систематических групп (рис. 55). Из этого рисунка хорошо видно, что доминируют в ультраабиссальной фауне в целом и особенно в ее средней и нижней подзонах представители лишь двух классов — голотурий и двустворчатых моллюсков. Если же учесть сравнительно крупные размеры голотурий, то в сочетании с их высокой численностью это обусловливает их первенствующую роль в фауне желобов по всем количественным показателям (встречаемость, численность, биомасса).

Фауна верхней (переходной) подзоны не только гораздо разнообразнее по своему составу, но и значительно отличается от фауны бóльших глубин по количественному соотношению в ней разных систематических групп. Голотурии хотя и стоят по численности на первом месте, но составляют лишь около одной четверти населения этой подзоны. Далее, кроме двустворчатых моллюсков, большую роль играют офиуры и полихеты, а в горизонте 6—6,5 км также сипункулиды. В этом горизонте перечисленные пять групп составляют по численности более 70% всех многоклеточных животных.

Роль сипункулид практически сходит на нет глубже 7 км, офиур — глубже 7,5 км. Глубже 10 км резко возрастает роль по численности актиний, главным образом за счет значительного развития на этих глубинах в Марианском и Филиппинском желобах представителей семейства галатеантемид.

Следует еще раз оговорить, что все приведенные показатели основаны на траловых уловах. Однако некоторые животные (в основном придонные) легко избегают поимки тралами, что не позволяет сколько-нибудь достоверно судить об их численности. На максимальных глубинах это, например, относится к хорошо плавающим придонным амфиподам. Только использование более современных методов лова и наблюдений (ловушки с приманкой; приманки, контролируемые фотокамерой) позволило впервые установить, что амфиподы крайне многочисленны на глубинах 9,5—10,5 км в Филиппинском и Марианском желобах [Wolff, 1976a; Hessler et al., 1978]. Только в ловушку с приманкой удалось впервые поймать несколько глубже 6 км и рыбу из семейства макрурид [Okutani, 1982].

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determines their predominant role in the trench fauna for all quantitative indicators (frequency, population and biomass).

The upper (transitional) subzone fauna is not only much more diverse in its composition, but differs considerably from the fauna of greater depths in quantity in it of different taxonomic groups. Although Holothurioidea are dominant in population, they only comprise one-fourth of the population of this subzone. Further, in addition to Bivalvia, Ophiuroidea and Polychaeta play a large role, and in the 6-6.5 km level also Sipunculoidea. The five listed groups in this level comprise over 70% of all the Metazoa.

The role of Sipunculoidea is essentially nullified below 7 km and Ophiuroidea below 7.5 km. Below 10 km there is a sharp increase in the population role of Actinea, mainly due to the considerable development of representatives from the Galatheanemum family.

It should be stipulated once more that all of these indicators are based on trawling catches. However, some animals (mainly near-bottom) easily avoid capture by the trawls which prevents a reliable judgment of their population. At the maximum depths, e.g., this refers to the easily floating near-bottom Amphipoda. Only the use of more modern capture methods and observations (traps with bait; camera-monitored bait) made it possible to establish for the first time that Amphipoda are extremely numerous at depths 9.5-10.5 km in the Philippine and Mariana trenches [Wolff, 1976a; Hessler et al., 1978]. For the first time several fish from the Macruridae family [Okutani, 1982] were caught somewhat below 6 km only in a bait-trap.

Figure 55. Percentage Correlation of Number of Animals of Different Groups in Trawling Catches at Different Depths (mean data for each 500-meter level)

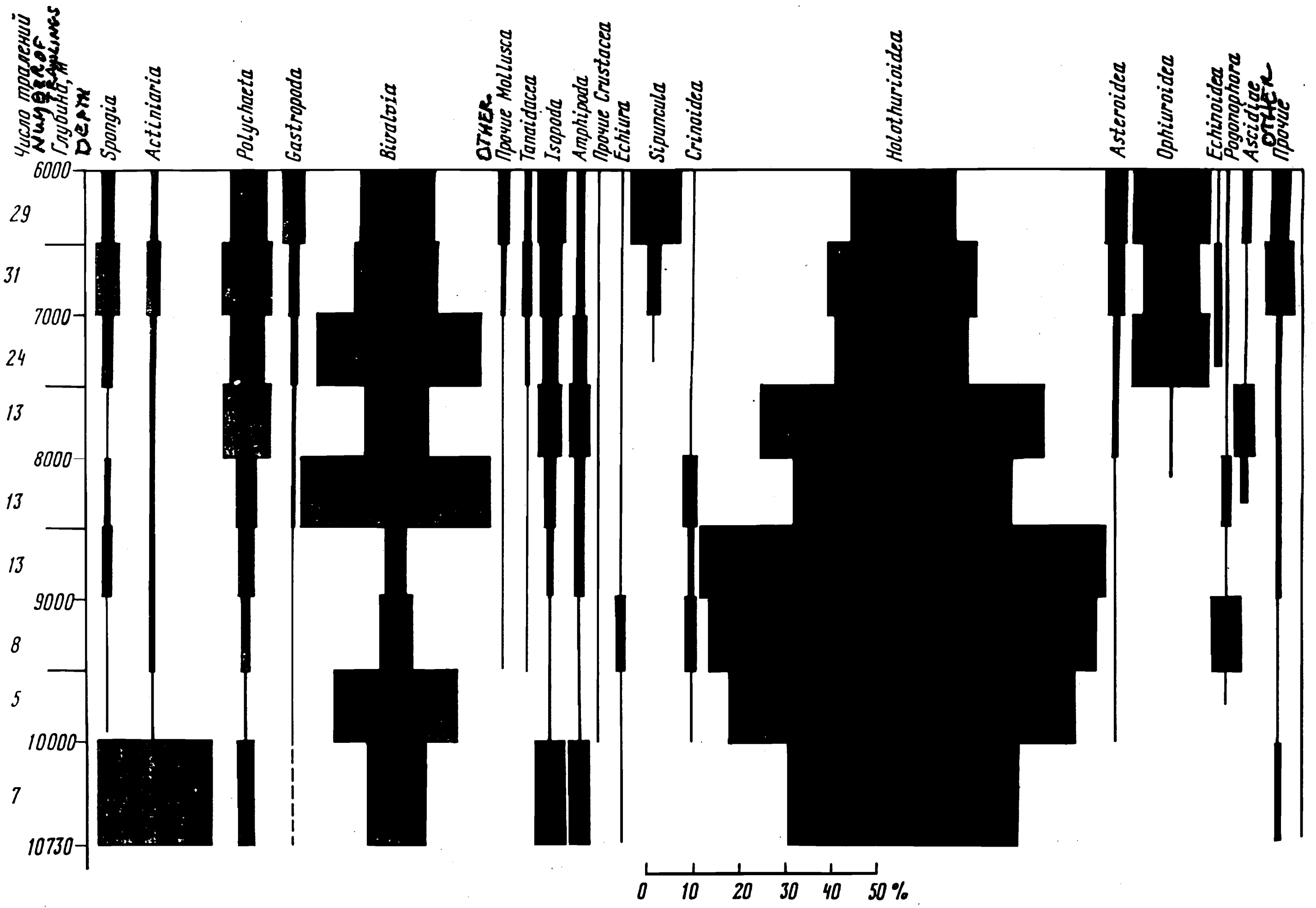

Рис. 55. Процентное соотношение числа животных разных групп в траловых уловах на разных глубинах (средние данные для каждого 500-метрового горизонта)

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TABLE 11
GREATEST DEPTHS OF FINDING DIFFERENT GROUPS OF ANIMALS DWELLING BELOW 6,000 m

Таблица 11

Наибольшие глубины нахождения разных групп животных, обитающих глубже 6000 м

Группа 1	Наибольшая глубина нахождения, м 2	Желоб или котловина (э/с и № станции) * 3	Животное 4	Источник 5
1	2	3	4	5
Foraminifera	10415–10687	Тон (”В”, 3823А) TON	Normanina ultraabyssalis Saidova Sorosphaera abyssorum (Saidova)	Саидова, 1975 9
Xenophiophoria	6675–6710	JAP Япон (”В”, 5617)	Stannophyllum granularium Tendal	Tendal, 1972
	8021–8042	PL Пал (”SpFB”, РФ-1)	S. mollum Tendal**	Lemche et al., 1976
	7847–8662	BG Буг (”SpFB”, РФ-8)	Представители родов 8 Psammetta, Cerelasma и Stannoma**	То же 10
Spongia				
Hyalospongia	6860	КК (”В”, 2144)	Hyalonema sp.	Зенкевич и др., 1955 11
	8530–8540	VOLC Волк (”В”, 7389)	–	Беляев, Миронов, 1977а 12
Demospongia	9980–9990	Фил (”В”, 7207) PLP	Asbestopluma sp.	То же 10
Hydrozoa				
полипы 6	8210–8300	Кер (”Gal”, 649)	Halisiphonia galatheae Kramp	Kramp, 1956
медузы 7	8700–6800***	КК (”В”, 5626)	Voragonema profundicola Naumov	Наумов, 1971 13
	8258–8260	NB НБ (”SpFB”, РФ-5)	Rhopalonematidae (? Crossota sp.)**	Lemche et al., 1976
Scyphozoa				
полипы 6	9995–10015	Кер (”В”, 3831)	Stephanoscyphus sp.	Беляев, 1966б 14
медузы 7	7847–8162	BG Буг (”SpFB”, РФ-8)	сем. Ulmaridae**	Lemche et al., 1976
Anthozoa				
Gorgonaria	8021–8042	PL Пал (”SpFB”, РФ-2)	Primnoella sp.**	То же 10
Alcyonaria	6006	P Пер (”Elt”, 37)	–	Menzies, 1963, 1964
Pennatularia	6620–6730	Кер (”Gal”, 650)	Umbellula sp.	Madsen, 1956a
	?7875–7921	NB НБ (”SpFB”, РФ-6)	–	Lemche et al., 1976**
Antipatharia	8175–8840	КК (”В”, 3176)	Bathypates patula Brock	Пастернак, 1958 15
Actiniaria	10700–10730	M Мар (”В”, 7359)	Galatheanthemum sp.	Беляев, Миронов, 1977а 12
Madreporaria	6296–6328	AL Ал (”В”, 4120)	Fungiacyathus symmetricus aleuticus Keller	Келлер, 1976 16
	6380	JAP Япон (”В”, 3593)	–	Беляев, 1966б 14
Turbellaria	7265–7295	КК (”В”, 5608)	–	Беляев, 1972 14
Nematodes	6313	P Пер (”АВ”, 191)	Desmoscolex velifer Timm	Timm, 1970
	10415–10687	TON Тон (”В”, 3823А)	–	Беляев и др., 1958 14
Priapuloidea	7795–8015	КК (”В”, 5616)	Priapulus tuberculatospinosus abyssorum Menzies	Мурина, 1971 17
Loricifera	8260	IB ИБ (”НМ”, 9)	Pliciloricus hadalis	Kristensen, Shirayama, 1988
Nemertini	7210–7230	КК (”В”, 2208)	–	Зенкевич и др., 1955 11
Polychaeta	10700–10730	M Мар (”В”, 7359)	Macellicephalinae sp.	Беляев, Миронов, 1977а 12
Oligochaeta	7298	AL Ал (”TW”, H-39)	Bathydrillus hadalis Erseus	Erséus, 1979
Echiuroidea	10150–10210	PLP Фил (”Gal”, 419)	Vitjazema sp.	Zenkevitch, 1966
Sipunculoidea	6850	КК (”В”, 2144)	Golfingia muricaudata (Southern), Phascolion lutense Selenka, Ph. pacificum Murina	Мурина, 1957, 1961, 1964 17

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Таблица 11 (продолжение)

1	2	3	4	5
Acariformes	6770–6850	IB ИВ ("В", 7407)	Bathyhalacarus quadricornis Sokolow et Yankowskaja	Янковская, 1978 22
Crustacea				
Copepoda				
Calanoida	8500–6000***	КК ("В", 2218)	Пойманы рачки 20 видов (см. Приложение II, табл. 7) 20	Бродский, 1955а 23
Harpacticoida	6580–6650	M Мар ("В", 7360)	Bradya sp. n. Chislenko	Беляев, Миронов, 1977а 12
	9995–10015	Кер ("В", 3891)	–	Беляев и др., 1960 14
Ostracoda				
пелагические 18	9500–7280***	КК ("В", 5626)	Archiconchoecia maculata Chavtur, Bathyconchoecia paulula pacifica Chavtur, Paraconchoecia vitjazi (Rudjakov)	Рудяков, 1962; Чавтур, 1977 24
донные 19	7950–8100	PR ПР ("АК", 1189)	Retibythere (Bathÿbythere) scaberrima (Brady)	Шорников, 1987 25
Cirrpedia	7420–7880	PLP Фил ("В", 7206)	Arcoscalpellinae sp. 2 Zevina	Зевина, 1977 26
Mysidacea	8560–8720	YAP Яп ("В", 7298)	Paramblyops sp. n. Chindonova	Чиндонова, 1981 27
Cumacea	7160	Y Яв ("Gal", 466)	Makrokylindrus hadalis Jones	Jones, 1969
	6920–7657	BG Буг ("В", 3655)	Bathycuma sp. n. Lomakina	Ломакина, 1969 28
	7974–8006	BG Буг ("В", 3663)	– (juv.)	Беляев, 1966б 14
Tanaidacea	8928–9174	Кер ("В", 3827)	Leptognathia longiremis Lilljeborg?	Кудинова-Пастернак, 1972 29
Isopoda	10700–10730	M Мар ("В", 7359)	Macrostylis sp.	Беляев, Миронов, 1977а 12
Amphipoda	10150–10190 10592	PLP Фил ("Gal", 418) M Мар ("TW")	Hirondellea gigas (Birstein et Vinogradov)	Dahl, 1959; Hessler et al., 1978
Decapoda	6364–6373	CA Кайм (Б) ("JEP", 575)	Glyphocrangon atlantica Chace	Holthuis, 1971
Pantopoda	7370	JAP Япон ("В", 6151)	Nymphon longitarse caecum Turpaeva, N. tripectinatum Turpaeva	Турпаева, 1971б 30
Aplacophora	8980–9043	BG Буг ("В", 3663а)	Prochaetoderma sp.	Бирштейн, Соколова, 1960; определение Д.Л. Иванова 31
Loricata	6920–7657	BG Буг ("В", 3655)	Leptochiton vitjazi (Sirenko)	Сиренко, 1977 32
	7000–7170	PL Пал ("В", 7289)	Leptochiton sp.	Беляев, Миронов, 1977а 12
Monoplacophora	6156–6489	P Пер ("АВ", 100)	Vema ewingi Clarke et Menzies	Clarke, Menzies, 1959; Menzies, 1968
Gastropoda	10415–10687	TON Тон ("В", 3823А)	– (пустые раковины) 21	Беляев и др., 1960 14
Cyclobranchia	9520–9530	КК ("В", 5628)	Bonus petrochenkoi Moskalev	Москалев, 1973 33
Septibranchia	6290–6300	PLP Фил ("В", 7213)	Fissurellidae sp.	Беляев, Миронов, 1977а 12
Pectinibranchia	8330	ПР PR ("АК", 1183)	Fedicovella sp. n. 2 Moskalev	Москалев, 1976; личное сообщение 34
Opisthobranchia	7974–8006 7970–8035	BG Буг ("В", 3663) PL Пал ("В", 7289)	Volvula sp. 2 Minichev –	Миничев, 1969 35 Беляев, Миронов, 1977а 12
Scaphopoda	6900–7000	Y Яв ("Gal", 465)	Siphonodentallium galatheae Knudsen	Knudsen, 1964
	6920–7657	BG Буг ("В", 3655)	–	Беляев, 1966б 14

Таблица 11 (окончание)

1	2	3	4	5
Bivalvia	10150–10190	PLP Фил ("Gal", 418)	Parayoldiella hadalis (Knudsen)	Knudsen, 1970; Филатова, Шилейко, 1985 36
	10700–10730	M Мар ("B", 7359)	Vesicomya sp.	Беляев, Миронов, 1977а 12
Cephalopoda	7280	CA Кайм (Б) ("JEP")	Grimpoteuthis sp.	Voss et al., 1977
	8100	КК ("B", 162)	Octopoda (ближе не определен) 43	Ушаков, 1952 37
Crinoidea	9715–9735	IB ИБ ("B", 3494)	Bathycrinus sp. n.	Беляев, 1966б 14
Holothurioidea	10700–10730	M Мар ("B", 7359)	Prototrochus sp. n.	Беляев, Миронов, 1977б, 12 1982 (P. bruuni Hansen?)
Asteroidea	9980–9990	PLP Фил ("B", 7207)	Hymenaster sp.	Беляев, Миронов, 1977а 12
Ophiuroidea	8060–8135	КК ("B", 5615)	Perlophiura profundissima Bel. et Litvinova	Беляев, Литвинова, 1972 38
Echinoidea	7335–7340	B Бан ("B", 7271)	Pourtalesia heptneri Mironov	Миронов, 1978б 39
Bryozoa	8210–8230	Кер ("Gal", 649)	Bugula sp.	Wolff, 1960
	8185–8400	КК ("B", 5612)	–	Беляев, 1972 14
Brachiopoda	7847–8662	BG Буг ("SpFB", PФ-8)	Phaneroporidae?	Lemche et al., 1976** Зезина, 1985 40
Enteropneusta	8100	КК ("B", 162)	Glossobalanus tuscarorae Belichov	Белихов, 1971 41
Lophenteropneusta	8258–8260	NB НБ ("SpFB", PФ-5)	–	Lemche et al., 1976**
	7847–8662	BG Буг ("SpFB", PФ-11)		То же 10
Pogonophora	9715–9735	ИБ ("B", 3494) IB	Heptabrachia subtilis Ivanov	Ivanov, 1957
Ascidiacea	8330–8430	КК ("B", 2120)	Situla pelliculosa Vinogradova	Виноградова, 1969а 42
Osteichthyes	8370	PR ПР ("JEP", 1168)	Abyssobrotula galatheae Nielsen	Staiger, 1972; Nielsen, 1977

*Объяснение сокращенных названий желобов, котловин и экспедиционных судов см. в Приложении.

**Определения по фотографиям дна.

***Горизонт лова планктонной сетью.

Примечание. Прочерк означает, что более точного определения нет.

СВОЕОБРАЗИЕ ДОННОЙ ФАУНЫ РАЗНЫХ ЖЕЛОБОВ

Наибольшие различия как по групповому составу фауны, так и по соотношению численности отдельных групп в разных желобах присущи верхней подзоне, и особенно ее верхнему пятисотметровому горизонту. Именно в этой подзоне с ее наиболее разнообразной фауной ярче всего выявляется своеобразие фауны, свойственное различным районам и отдельным желобам. Некоторые группы животных, характерные для одних районов, отсутствуют или не имеют существенного значения в других.

Так, например, сипункулиды на глубинах 6–7 км в желобах северной части Тихого океана занимают третье место по численности (после голотурий и офиур) и представлены в 67% уловов, а в наибольших понижениях глубоководных котловин этой части океана они преобладают над животными всех других групп. В других желобах сипункулиды или не обнаружены, или представлены единичными экземплярами.

Офиуры, вообще характерные для глубин 6–7 км, в желобах северной части Тихого океана занимают по численности второе место, уступая лишь голотуриям.

Page 123 End of Table 11

Key:
1. Group
2. Greatest depth of finding, m
3. Trench or trough (research vessel and No. of station)*
4. Animal
5. Source
6. Polyps
7. Medusa
8. Representatives of the genera Psammetta, Cerelasma and Stannoma
9. Saidova
10. The same
11. Zenkevitch et al.
12. Beliaev, Mironov
13. Naumov
14. Beliaev
15. Pasternak
16. Keller
17. Murina
18. Pelagic
19. Benthic
20. 20 species of Ostracoda were caught (Appendix II, Table 7)
21. (empty shells)
22. Yankovskaya
23. Brodskiy
24. Rudyakov, Chavtur
25. Shornikov
26. Zevina
27. Chindonova
28. Lomakina
29. Kudinova-Pasternak
30. Turpayeva
31. Birstein, Sokolova, determination of D. L. Ivanov
32. Sirenko
33. Moskalev
34. Moskalev, personal report
35. Minichev
36. Filatova, Shileyko
37. Uschakov
38. Beliaev, Litvinova
39. Mironov
40. Zezina
41. Belikhov
42. Vinogradova
43. Not defined more closely

* See the Appendix for the explanation of the abbreviations of the trenches, troughs and research vessels.
** Analyses from bottom photographs.
***Level of catch by a plankton net.
Comment: The dash means that there is not a more accurate analysis.

UNIQUENESS OF BENTHIC FAUNA IN DIFFERENT TRENCHES

The greatest differences both in group composition of the fauna, and in correlation of the population of individual groups in different trenches are inherent to the upper subzone, and especially its upper 500-meter level. It is precisely in this subzone with its most diverse fauna that the uniqueness of the fauna is revealed most clearly, inherent to different regions and individual trenches. Some groups of animals that are characteristic for some regions are missing or do not have significance in others.

Thus, for example, Sipunculoidea at depths 6-7 km in northern Pacific Ocean trenches are in third place in population (after Holothurioidea and Ophiuroidea) and are represented in 67% of the catches, while in the greatest depressions of the deep-sea troughs in this part of the ocean they dominate over the animals of all other groups. In other trenches Sipunculoidea either are not found or are represented by single specimens.

Ophiuroidea, generally characteristic for depths 6-7 km, occupy the second place in population in northern Pacific Ocean trenches, inferior only to Holothurioidea.

Conversely, at these depths in the Peru trench their role is relatively low, and from six trawling hauls obtained in the Yavan trench, a single Ophiuroidea was found in one of them.

Holothurioidea which almost universally dominates at depths over 7 km maintain their dominant position also in the upper subzone only in the northern Pacific Ocean trenches and in the Kermadec and New Hebrides trenches. In the other trenches, despite the fact that Holothurioidea are represented in almost all the catches, their population at depths 6-7 km is comparatively low, especially in the Peru[1] and Chile trenches. In the latter they comprised less than 10% of the caught animals even in the haul from depth 7,720 m. Despite the dominance of Holothurioidea in the northern Pacific Ocean trenches, there are very few in the catches obtained from depths 6-6.5 km in the troughs of this part of the ocean (slightly more than 1% in population). This is due to the considerably less favorable feeding conditions in trough sections far from the coasts where collections were made than in the coastal trenches of this part of the ocean. Deep-sea Holothurioidea mainly belonging to the forms that collect detritus from the surface of the floor apparently react very sensitively to deterioration in the feeding conditions. Per the data of M. N. Sokolova [1969], at abyssal depths (3-6 km) the dissemination of detritus-eating Holothurioidea is confined predominantly to the peripheral ocean sections, i.e., to its more eutrophic regions.

It is characteristic that Spongia (microplankton-eating in feeding type), widespread in the abyssal of the oligotrophic ocean regions [Sokolova, 1969], only in the Pacific Ocean troughs are encountered at depths over 6 km in all hauls and in the fauna occupy the second place in population (12%). The importance of Spongia in the trench fauna is usually very low (with the exception of the sub-Antarctic South Sandwich trench.

The role of Euchiuroidea in the ultra-abyssal fauna on the whole is comparatively minor. Nevertheless, they are very characteristic for northern Pacific Ocean trenches where they are found at all ultra-abyssal depths (frequency 60%). Of the total number of Euchiuroidea specimens collected below 6 km, over 80% occur in these trenches. The frequency of Euchiuroidea in all other trenches is less than 25%.

Bivalvia and Polychaeta dominate in the Peru trench fauna (6-6.5 km). Mollusks of the Monoplacophora class are also a very characteristic component of its fauna and they are not found in any other trenches.

The Yavan trench fauna is very unique. At depths 6-7 km different mollusks comprising over 80% of all the fauna (including Bivalvia, 66%) were very abundant in it. Only in this trench the mollusks of classes Aplacophora and Scaphopoda are important in the fauna, in other trenches they are either missing or play an insignificant role. The Yavan trench is also characterized by such Echinus found in it at depths 6-7 km in two hauls of five, and once in a considerable quantity. The Yavan trench fauna is also characterized by a very modest role in the upper subzone of Holothurioidea and occupies a dominant position in it.

Undoubtedly, in many cases differences in the group composition and in quantitative dominance of certain groups in the fauna of the upper ultra-abyssal zone of different ocean regions are related to the feeding conditions as occurs in relation to Spongia and Holothurioidea in the northern Pacific Ocean trenches and troughs. Additionally, the reasons for these differences could also be linked to the history of fauna formation of certain regions. Numerous findings of Monoplacophora only in the Peru trench are due to the predominant dissemination of modern Monoplacophora precisely in the southeast Pacific Ocean and its neighboring regions [Moskalev et al., 1983], which apparently has historical roots.

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[1] It is true that the mosaic distribution of Holothurioidea possibly plays a role here. On the photograph of the floor covering an area 0.7 m^2 and obtained in the Peru trench at depth somewhat over 6 km [Menzies, 1963], 3 specimens of Holothurioidea of the order Elasipoda are visible with length about 5 cm whose biomass should be no less than 25 g/m^2.

As for the ultra-abyssal medium and lower subzone, in them in almost all the studied trenches the main role in population belongs to the Holothurioidea, and Bivalvia are usually in the second place. Of the other groups, the most important are Polychaeta, Actinia, Isopoda and Amphipoda, while the role of other groups is generally minor. The differences between the trench fauna are mainly manifest at the level of species, and to a lesser degree, genus taxons.

Chapter 7

QUANTITATIVE ABUNDANCE

The quantitative abundance of benthic animals in the trenches may be judged to a certain degree: a) by the population and biomass of animals in the botttom grab samples; b) by the relative abundance of animals in the trawling catches; c) by bottom photographic data; d) by the animals collected on the camera-monitored benthic bait, and by the hauls in the bait traps.

BOTTOM GRAB SAMPLES

Sixty bottom grab samples (bottom grabs Okean or Petersen with area 0.2-0.25 m^2 have been obtained by now below 6 km from 18 trenches and 4 troughs for which data are known about the number of caught animals and their biomass converted for 1 m^2 of bottom. Data on these samples are cited in Appendix I. It should be noted that these bottom grab models in many cases do not provide a complete collection of meiobenthos since the surface soil layer is partially washed away when the bottom grab is lifted, especially if it is filled with sediment only partially; the microbenthos and part of the meiobenthos are lost when the soil is washed on sieves with cell size 0.5 mm. Additionally, there can only be confidence of the sample sufficient representation only on soft soils of the bottom horizontal surfaces when the bottom grab comes to the surface filled with sediment. Finally, due to the small area of the bottom grab it does not provide an idea about the mosaic of the more or less large animals distributed on the bottom (megafauna and partially macrofauna), and one large animal that randomly enters the sample should not be considered since otherwise the biomass indicator is severely distorted compared to the overwhelming majority of the other samples.

Considering all of this, it is understandable that the population and biomass indicators from the bottom grab trench samples fluctuate in very broad limits: population from 4-5 to 1,200 specimens/m^2, i.e., 300 times, and biomass (without consideration for Foraminifera) from 10 mg/m^2 to almost 19 g/m^2, i.e., almost 2,000 time. It is true that within individual trenches these oscillations are considerably lower which permits a comparison of some mean indicators.

Thus, based on the samples obtained in the trenches of the highly productive ocean regions: trenches of the Pacific Ocean temperate latitudes, Aleutian, Kuril-Kamchatka, Japan, Chile (12 samples), sub-Antarctic Hjort and South Sandwich trenches (4 samples), as well as the Peru trench (6 samples), although it is located in the tropical latitudes, but is confined to the highly productive region of the Peru upwelling, the biomass indicators in 20 of 22 samples do not exceed the differences by one order of magnitude (from 0.3 to 4.84 g/m^2) and only 2 samples yielded even higher indicators: in the South Sandwich trench 8.88 g/m^2 at depth 6,875 m and in the Peru trench 18.7 g/m^2 at depth

6,100 m. The mean indicator for all the listed trenches is 3.20 g/m^2. The same magnitude was inherent to the Banda trench (n=5, with fluctuation scope from 0.56 to 12.5 g/m^2, M=5.18 g/m^2) which is apparently explained by the location of this trench in the comparatively small Banda Sea which is surrounded on all sides by numerous islands and shoals, thus explaining the abundant removal in it of organic matter.

Another picture is presented of the mean indicators, on the one hand, for samples obtained in ocean depressions slightly over 6 km in ocean troughs in sections located a considerable distance from the coasts of continents or large islands, and on the other hand, for all the trenches confined to the tropical latitudes (except for the Banda and Peru trenches). For the 10 samples obtained in the Pacific Ocean troughs and one in the Canary trough of the Atlantic, the biomass oscillations are f rom 0.02 to 2.16 g/m^2, and averages 0.34 g/m^2. An even clearer reduction in biomass was expressed for the tropical latitude trenches. For 9 of these trenches located in all three oceans, the biomass indicators from 22 bottom drag samples fluctuated from 0.01 to 0.56 g/m^2, and averaged 0.124 g/m^2 (in one case the finding of an Asteroidea weighing about 1 g was not considered).

Of course these numbers are relative and there is a great degree of randomness in them, but the tendency towards significant biomass reduction from the trenches located in the ocean eutrophic regions in the direction of the meso- and oligotrophic regions is fairly graphic.

In the Yavan trench, located in the region characterized by relatively high productivity of surface waters, unfortunately only two bottom grab samples have been obtained from depths of its slope 6,487 and 6,841 m that differ strongly in biomass (0.09 and 0.56 g/m^2). It is of course difficult to judge the degree of representation of these data from only two samples. But judging from the extremely massive trawling catch obtained by Galathea (see Table 6), the greatest depths of the flat bottom of this trench are characterized by a quantitative abundance of animals that is comparable to that in the trenches of the most eutrophic ocean regions.

A new and more advanced box corer obtained one sample in the Aleutian trench [Jumars, Hessler, 1976] and three samples in the Japan [Shin, 1984]. The sample in the Aleutian trench came from depth 7,298 m on the floor along the trench axis and was washed on a sieve with mesh 0.3 mm. The total population of animals in this sample was 856 specimens or 3,424 specimens/m^2 which is almost 3 times greater than the most abundant sample previously obtained below 6 km (Vityaz, st. 6139, Aleutian trench, 1,200 specimens/m^2, 4.64 g/m^2). Of the three samples obtained in the Japan trench from depths 6,980, 7,460 and 7,550 m, the animals were selected only from an area 0.09 m^2 in each sample after washing on a sieve with mesh 0.5 mm. Their population was 144, 322 and 833 specimens/m^2. The number of animals in the previous, single sample from the Japan trench (Vityaz, st. 7511, 7500 m) was 400 specimens/m^2 and biomass 4.84 g/m^2. As is apparent, with the use of a more advanced bottom drag the magnitude remains the same. I am not aware of any data on the population of animals in the 13 samples taken by the box corer in the Philippine trench [Hessler et al., 1978].

TRAWLING YIELDS

The difference in the abundance of trawling catches and in the change in this abundance with depth between the trenches of highly-productive eutrophic ocean regions and trenches of low-productive regions is even more distinctive than in the bottom grab samples. In order to obtain more or less representative data the information on trawling catches was summarized, on the one hand, for three very similar eutrophic northern Pacific Ocean trenches (45 hauls from the Aleutian, Kuril-Kamchatka and Japan trenches), and on the other hand, for tropical latitude trenches of the western Pacific Ocean that are characterized by much sparser fauna (49 catches from Banda, Philippine, Palau, Yap, Mariana, Volcano, Bougainville, New Hebrides and Tonga trenches, as well as Ryukyu and Izu-Bonin). The last two trenches although they are formally located beyond the tropical latitudes, in relation to abundance, their fauna are considerably closer to the tropical trenches than to the three trenches of the first group. The comparison results are given in Table 12 (neither trench groups take into consideration the clearly unsuccessful trawlings in whose catches there were less than 5 specimens of animals: in the first group of 2 such trawlings and in the second, 5).

TABLE 12
CHANGE WITH DEPTH OF MEAN NUMBER OF SPECIMENS AND SPECIES OF ANIMALS IN ONE TRAWLING CATCH IN THE TRENCHES OF DIFFERENT REGIONS

Key:
1. Level, m
2. Number of trawling catches
3. Number of specimens
4. Number of species
5. Mean number of specimens for 1 species
6. Eutrophic trenches of northern Pacific Ocean
7. Trenches of tropical and subtropical latitudes in western Pacific Ocean

As is apparent from Table 12, the benthic fauna of the eutrophic trenches is characterized by the following indicators.

1. The number of animals in the haul numbers in the hundreds or thousands of specimens, and a natural increase is observed in the numerical abundance of catches as the depth increases (all catches below 9 km were obtained on the bottom of the Kuril-Kamchatka trench).

2. The mean number of species in one catch diminishes naturally with depth, and correspondingly, the mean number of specimens for one species increases.

These data indicate that on the floor of the Kuril-Kamchatka trench there are conditions that promote a considerably more abundant quantitative development of fauna than in the overlying levels. It is natural to hypothesize that this is determined by more favorable feeding conditions on the trench floor compared to its slopes. At the same time, the pronounced reduction in the number of species at the greatest depths may apparently be linked only to the increase in hydrostatic pressure beyond the limits

Таблица 12

Изменение с глубиной среднего числа экземпляров и видов животных в одном траловом улове в желобах разных районов

Горизонт, км 1	Число траловых уловов 2	Число экз. 3	Число видов 4	Среднее число экз. на 1 вид 5
	Эвтрофные желоба северной части Тихого океана 6			
6–7	16	395	33	12
7–8	13	706	26	27
8–9	10	954	22	43
9–10	6	7074	12	590
	Желоба тропических и субтропических широт 7 западной части Тихого океана			
6–7	11	152	17	9
7–8	16	126	16	8
8–9	12	84	10	8,5
9–10	4	116	13	9
10–11	6	39	6	6,5

фауной (49 уловов из желобов Банда, Филиппинского, Палау, Яп, Марианского, Волкано, Бугенвильского, Ново-Гебридского и Тонга, а также Рюкю и Идзу-Бонинского). Последние два желоба хотя и расположены формально за пределами тропических широт, но в отношении обилия их фауны стоят значительно ближе к тропическим желобам, чем к трем желобам первой группы. Результаты проведенного сравнения представлены в табл. 12 (в обеих группах желобов не учтены явно неудачные траления, в уловах которых было менее 5 экз. животных: в первой группе 2 таких траления, во второй – 5).

Как видно из табл. 12, донная фауна эвтрофных желобов характеризуется следующими показателями.

1. Число животных в улове исчисляется сотнями или тысячами экземпляров, причем наблюдается закономерное увеличение численного обилия уловов по мере увеличения глубины (все уловы глубже 9 км получены на дне Курило-Камчатского желоба).

2. Среднее число видов в одном улове закономерно уменьшается с глубиной, и соответственно этому возрастает среднее число экземпляров на один вид.

Приведенные данные свидетельствуют о том, что на дне Курило-Камчатского желоба существуют условия, способствующие значительно более обильному количественному развитию фауны, чем в вышележащих горизонтах. Естественно предположить, что это определяется более благоприятными условиями питания на дне желоба по сравнению с его склонами. Вместе с тем четко выраженное снижение числа видов на наибольших глубинах, видимо, можно связывать только с увеличением гидростатического давления за пределы, переносимые подавляющим большинством глубоководных животных. Немногие же приспособившиеся к этим условиям виды достигают здесь массового развития.

Для желобов малопродуктивных районов тропических широт характерны следующие особенности.

1. Среднее число животных в улове на всех глубинах составляет от нескольких десятков до полутора сотен экз., т.е. в несколько раз, а для горизонта 9–10 км более чем в 60 раз, меньше, чем в эвтрофных желобах.

2. В противоположность эвтрофных желобам в мезо- и олиготрофных желобах не наблюдается возрастания численности животных в уловах по мере увеличения глубины.

3. Среднее число видов в улове на глубинах до 9 км примерно вдвое меньше, чем в эвтрофных желобах; в горизонте 9–10 км оно в обоих случаях почти одинаково,

endured by the overwhelming majority of deep-sea animals. Some of the species that have adapted to these conditions reach mass development here.

The following features are characteristic for trenches of low-productive tropical latitude regions.

1. The mean number of animals in the catch at all depths is from several dozen to one-hundred fifty specimens, i.e., several times, and for level 9-10 km more than 60 times, less than in the eutrophic trenches.

2. In contrast to the eutrophic trenches in the meso- and oligotrophic trenches there is no increase in the number of animals in the catches as the depth increases.

3. The mean number of species in the catches at depths up to 9 km is approximately twice lower than in the eutrophic trenches; in level 9-10 km in both cases it is almost the same,

and in level 10-11 km it drops even twice. The mean number of specimens for 1 species essentially does not change in the entire depth range.

The tropical latitude trenches thus are characterized by a considerably lower quantitative abundance of fauna. This paucity is inherent to all the depths of these trenches, and undoubtedly is due to the scarcity of food resources, a leading factor in the entire depth range of the ultra-abyssal zone. Whereas at the maximum depths on the floor of these trenches and organic substances are accumulated that are suitable for feeding benthic animals, its scales are insufficient to support the mass development of the benthic species dwelling here, similar to that observed in the eutrophic trenches.

Among the other studied trenches, the sub-Antarctic South Sandwich trench has very abundant trawling catches. In five trawlings made in it at depths from 6,100 to 8,100 m, the number of caught animals fluctuated from 640 m to 7,500 specimens (M=3,240 specimens). At depth 6,800 m the most mass were Hyalospongia, at 7,200 m Ophiuroidea, at depth 6,100 m and at the greatest depths (7,800 and 8,060 m), mass populations of several species of Holothurioidea (72-78% in population)[1] played the main role. Similar mass populations of Holothurioidea were found in the deepest sample from the Yavan trench and on the flat bottom of the Kermadec trench at depth over 8 km in its most southern part, close to the highly productive New Zealand region (Galathea, st. 466 and 649).

The quantitative abundance of animals in the trawling catches from three trenches of the Atlantic Ocean tropical latitudes (Puerto Rico, Cayman and Romanche) is characterized by fairly similar indicators. In the 15 trawling catches obtained in these trenches from depths from 6,300 to 8,300 m the number of species fluctuates from 6 to 28 (M=14), the number of species from 12 to 450 (M=15), while the mean number of individuals for 1 species equals 13. As is apparent from a comparison with the data in Table 12, these indicators are fairly close to those from the trenches of the Pacific Ocean tropical latitudes.

POPULATION OF ANIMALS BASED ON BOTTOM UNDERWATER PHOTOGRAPHS

The data of Lemche et al. [1976] are of exceptional interest; they made a detailed study of the composition of organisms on approximately 4,000 color stereoscopic photographs of the floor from the American PROA expedition on the Spencer F. Baird in five trenches of the western tropical Pacific Ocean at 7 stations at depths from 6,700 to 8,900 m. In four of these trenches (Palau, New Britain, Bougainville and New Hebrides) they successfully calculated the density of a number of epibenthic species settlements based on an analysis of over 1,000 photographs, each of which covers a certain area of the bottom (from 0.5 to 10 m^2 depending on the distance of the camera from the floor); all photographs suitable for these calculations encompassed a floor area about 6,000 m^2.

It should primarily be noted that the extreme broad dissemination of the hypothetically bacterial accumulations found at the majority of stations have the appearance of dark thin films on the lighter surface of the floor. In the first three of the aforementioned trenches, these films cover enormous areas: "Possibly, from one-fourth to half of the flat bottom in the hadal zone" (p. 268). Apparently, these films play an important role in the diet of benthic animals. The authors observed on the photographs traces of their destruction by pseudopodia of Xenophyophorea or holothurians. Regarding

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[1] Unfortunately, in another sub-Antarctic trench, Hjort, all three trawlings made in it somewhat below 6 km (research vessel Dmitriy Mendeleyev) were not very successful (from 5 to 20 specimens of animals) which prevents a comparison with the South Sandwich trench.

Holothurioidea of the genus Elpidia in the New Britain trench they make special note of their common confinement to such bacterial films.

Large Xenophyophorea (see Chapter 4) in many cases are apparently the primary consumers of bacteria. Their pseudopodia can sometimes cover up to 30-50% of the floor surface. These data agree well with the recently established very major role of large Xenophyophorea at lower depths (to 3,350 m) in the eastern Pacific Ocean where they serve as food for many Metazoa, a substrate and shelter, and also accelerate settling of particles on the bottom from the water mass [Levin et al., 1986].

As for the epifauna Metazoa, although on the photographs usually animals less than 1 cm in size have not been determined, and sometimes even larger ones, nevertheless the authors defined in the studied trenches about 100 species of benthic and near-bottom animals and their population was sometimes considerably greater than might be expected based on the trawling catches from these trenches. Thus, for example, in the Palau trench (st. 2, 8,030 m) for every 10 m^2 of floor there were 2 specimens of Holothurioidea alone, 1 Elpida and 1 Peniagone (which already should yield a biomass of about 1 g/m^2). There were 3 specimens/10 m^2 of Ophiuroidea in the New Hebrides trench (st. 11), as well as comparatively large Holothurioidea as Scotoplanes and Hadalothuria 1 specimen each per 100 m^2. In the New Britain trench (st. 7, 7,000 m) for every 30 m^2 there was an average of one large (length up to 25 cm) isolated Ascidia, at st. 6 only 3 small Pennatularia (?) specimens per m^2, and at st. 6 there were 3 specimens/100 m^2 of each of two species of fairly large Holothurioidea (Elpidia solomonensis and Pseudostichopus sp.). It is curious that the mean population was calculated even for some animals that were found for the first time on photographs at depths below 6 km, e.g., for near-bottom Trachymedusae and Lophenteropneusta (1 specimen /100 m^2).

Judging from the data of Lemche et al., traditional methods of collecting benthic animals provide a very incomplete picture of life in the trenches located in low-productive ocean regions. Unfortunately, there is yet no similar data for the eutrophic trenches (like Kuril-Kamchatka) that could be no less surprising.

BAIT ATTRACTION OF BOTTOM-DWELLING ANIMALS

Extremely important and new data were obtained by the American expeditions on the Thomas Washington ship by lowering to the bottom autonomous instrument-carriers with bait (fish carcass bundles) monitored by camera. This work was done in the Philippine, Mariana and Chile trenches [Wolff, 1976a, 1977; Hessler et al., 1978]. Hauls of bottom-dwelling animals in autonomous baited traps (see Fig. 33, A) were also made in the first two trenches.

As was apparent from the previous sections of this chapter, mass clusters of benthic animals were not successful in the oligotrophic trenches either as a result of trawling hauls, or on bottom photographs. However, when bait was lowered to the bottom, it was found that enormous quantities of bottom-dwelling mobile scavengers collected on them.

During seven descents of bait in four sections on the Chile trench axis to depths about 7 km, numerous Amphipoda gathered to it, and only occasionally single shrimp (? or Mysidaceae), but never any fish. In one case, after the Amphipoda left the bait, Holothurioidea approached it. At the same time, on the ocean floor sections adjoining the trench, at depths 3.5-4.5 km diverse animals collected on the bait, including fish, Amphipoda, shrimp, etc. (see Fig. 36).

Even more indicative results were obtained in the Philippine and Mariana trenches. Bait was lowered in the first at several stations to depths about 9,600 and 9,800 m. Enormous quantities of Amphipoda of the only species Hirondelea gigas invariably gathered around this bait (dimensions of individuals of different ages from 1 to 4.3 cm) which was established by lowering an autonomous trap to the same depth with bait consisting of 16 individual sections with inlet holes tightened by a net with mesh of varying diameter. This trap caught over 4,300 H. gigas individuals of varying age (in the section with mesh from 6.4 to 12.7 mm) (see Fig. 34). Within two hours after lowering the bait to the bottom only a few Amphipoda were observed near it (see Fig. 35, A), the greatest clusters of thousands of Amphipoda were only observed within 12 h (Fig. 35, B). There are no direct data to judge the distance from which the Amphipoda gathered to the bait. However, considering their ability to swim fairly rapidly, it may be hypothesized that during the 12 h, Amphipoda gathered at the bait from distances at least from several hundred meters to 1-2 km. It seems to me that it is possible that not only the smell emitting from the bait attracts the crustaceans: after sensing the bait and going towards it, the crustaceans themselves release into the water some kind of attractants and thus can start a chain reaction of attracting crustaceans from a considerable distance. A camera and trap were used for monitoring on the slope of the Philippine trench at depth 5,861 m (110 km from the trench axis). In this case numerous fish from the family Brotulidae and sometimes Crustacea mainly gathered at the bait, and Amphipoda of two species of the genus Paralicella were caught in the trap, but no H. gigas. H. gigas did not appear at all in the 13 bottom grab samples and 8 trawling catches obtained by the American expeditions in the actual Philippine trench [Hessler et al., 1978], proof that these mobile crustaceans easily avoid normal traps.

Bait with a camera and trap were then used in the Mariana trench at depths from 7,355 to 10,592 m. As in the Philippine trench, the only mass species here was the same H. gigas (an exception was 1 specimen, apparently genus Orchomene, caught at depth 10.5 km).

These data indicate that in the trenches (in the same way as in the depths of the ocean floor), the so-called "rain of corpses" plays a major role in providing food for benthic animals, insofar as there are such mass numbers at maximum depths of mobile scavengers such as H. gigas that are especially adapted to this method of feeding.

It has been repeatedly noted that benthic bait at bathyal and abyssal depths attract numerous mobile scavengers not only in the eutrophic [Smith, 1985], but also in the oligotrophic ocean regions [Hessler et al., 1972; Schulenberger, Hessler, 1974]. Based on the calculations [Stockton, DeLaca, 1982], the organic matter falling to the bottom because of the "rain of corpses", pelagic animal feces[1] and large vegetation remains could be up to 0.2 g/m^2 x day, and the scattering of organic matter from the "rain of corpses" and eaten by the mobile scavengers could occur fairly rapidly to great distances, on the order of 1 hectare to 10 km^2. There is no doubt that even in such oligotrophic trenches as the Mariana, the "rain of corpses" is sufficient to support at all depths even to 10.5 km the mass populations of mobile bottom-dwelling scavengers H. gigas. Apparently, H. gigas in the other trenches in which this species dwells, including in the eutrophic Kuril-Kamchatka trench, forms no less massive populations all the way to the maximum depths.

The data on the quantitative abundance of life in the trenches of various ocean regions on the whole agree well with the data on the quantitative abundance of plankton in the surface waters of the corresponding regions. The plankton biomass in the eutrophic regions is usually 200-500 mg/m^3 (or more). In the coastal tropical trench regions it is on the order of 50-100 mg/m^3, and in the regions of the most oligotrophic trenches, such as the Tonga,

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[1] A special publication [Madin, 1982] covers the abundance on the floor of deep-sea regions of salp fecal pellets.

Mariana and Volcano, it is less than 25 mg/m^3. As already noted, the Peru and Yavan trenches, located in the tropical latitudes which produced very abundant trawling catches, are characterized by high productivity in the surface waters (for plankton biomass data see: [Bogorov, 1967; Bogorov et al., 1968; Vinogradov, 1968; Vinogradov et al., 1961; Kovalevskaya et al., 1968]).

The data on the quantitative development of benthic fauna in the trenches of various ocean regions generally agree with the data on the content of organic matter in the surface layer of the benthic sediment. Its highest content in the sediment of the northern Pacific Ocean is confined to marginal regions, in particular the Kuril-Kamchatka, Japan and Aleutian trenches. The concentration of organic matter (C_{org}) here (including in the actual trenches) is from 0.5 to 1.5% of dry sediment weight[1], while beyond the comparatively narrow coastal band, it does not exceed 0.5% on the ocean floor to the north of 30°n.l., and is less than 0.25% to the south of 30° n.l. In the central parts of the Pacific, Indian and Atlantic Oceans that are far from the coasts, the C_{org} content in the deep-sea sediments is also less than 0.25%, and in the most depleted sections of the Pacific Ocean it drops to less than 0.1%. The sediments of the deep-sea trenches located in these regions are just as sparse in organic matter as the sediments of the tropical regions of the open ocean (Volcano, Mariana, New Hebrides, Tonga) [Romankevich, 1968, 1970, 1977; Bogdanov et al., 1971]. It is natural that in this case we can only speak of the correspondence in the most general features, insofar as the content of organic matter in the sediment depends not only on the regional productivity, but also on many other factors (nature of the sediment, bottom relief, sedimentation rate, etc.). Moreover, among the benthic animals not all of them feed on the organic matter already contained in the sediment. For example, the filter-feeders feed on detritus from the bottom water layer, while the mobile scavengers that feed on the "rain of corpses" deplete the large clusters of organic matter that fall to the bottom so rapidly that they cannot be buried in the sediment.

The available data on the quantitative distribution and abundance of benthic fauna in the deep-sea trenches in various regions fit well into the common dissemination system in the World Ocean of trophic regions as established by the correlation of abyssal macrobenthos food groups [Sokolova, 1976, 1981, 1986].

As for the current plankton animals that are unrelated to the bottom, there are sparse data on their biomass at depths over 6,000 m. They are based on hauls made by expeditions on Vityaz by plankton nets in levels 6,000-7,000 m and 7,000-8,000 m only at several stations in the Kuril-Kamchatka trench [Vinogradov, 1968, 1970] and at two stations in the Bougainville and Kermadec trenches [Vinogradov, 1960a, 1968]. In all cases, a natural decrease was observed in the zooplankton biomass[2] as the depth increases to the least indicators at depths over 6,000 m. The zooplankton biomass in the Kuril-Kamchatka trench decreased from 450 to 950 mg/m^3 in the 50-meter surface layer to 0.50 -0.75 mg/m^3 in layer 6,000-7,000 m and to 0.31-0.32 mg/m^3 at depths 7,000-8,000 m (decrease of 1,000 to 1,500 time). Even compared to the abyssal depths (from 3,000 to 6,000 m), the zooplankton biomass below 6,000 m was 1.5-3 times less. This is undoubtedly linked to the constant decrease with depth of the food particles located in the water mass, insofar as their accumulation, as is characteristic for the sediment on the trench floor, does not occur in the water mass. The dominant group of animals in the ultra-abyssal mesoplankton of the Kuril-Kamchatka trench (as at lower depths) was Copepoda. There were very few representatives of macroplankton at these depths and they were encountered rarely. The mesoplankton biomass at depths 6,000-8,000 m in the Kermadec trench (st. 3892) was even less than in the Kuril-Kamchatka trench, 0.085 mg/m^3, and in the tropical Bougainville trench (st. 3663) was only 0.015 mg/m^3 (decrease compared to the biomass in the ocean surface layer at the same station 127 mg/m^3, almost 4 orders of magnitude).

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[1] The 1977 summary of Ye. A. Romankevich indicates that the C_{org} content in sediments fluctuates from 0.26 to 4.47% in the Peru-Chile trench within depths 6,100-7,320 m.

[2] M. Ye. Vinogradov cites data on mesoplankton (without considering Coelenterata and Salpa).

Chapter 8.

ZOOGEOGRAPHIC ZONIING OF THE ULTRA-ABYSSAL

As knowledge is accumulated about the composition and dissemination of botton dwellers of the sea and ocean bottoms, there is greater clarification of the differences in the laws to which the geographical dissemination is subordinate of the animals populating the various ocean vertical zones.

The zoogeographical zoning system was developed by N. G. Vinogradova [1956, 1959, 1969, 1977] for the abyssal World Ocean (3,000-6,000 m). In relation to the largest division into zoogeographical regions, this system is very close to the one proposed back in the 1930's by S. Ekman [1935, 1953], but differs from the latter in the greater detail (division into subregions and provinces). The substantiation of Vinogradov's system was confirmed as a result of detailed analysis of the dissemination of deep-sea Isopoda [Kussakin, 1971b; Kussakin, 1973].

Ye. F. Guryanova [1962] was the first to note the need to make an independent zoogeographical zoning not only for the sublittoral and abyssal, but also for other vertical zones, including for the bathyal and ultra-abyssal. This zoning for the bathyal was made as a result of the analysis of the dissemination of all species of modern Brachiopoda [Zezina, 1973].

As for the ultra-abyssal, although this zone is characterized by a very high degree of fauna isolation from the overlying ocean vertical zones, there are no grounds to isolate it into a special zoogeographical region. The fact is that in a zoogeographical sense, the depths over 6 km are not a single entity, separate deep-sea trenches or chains of neighboring trenches are located in different oceans or in different parts of a certain ocean, and are separated by enormous spaces of abyssal depths, and sometimes even lower depths (Banda and Cayman trenches). Correspondingly, the specific nature of the fauna species composition is mainly inherent to specific trenches or groups of neighboring trenches.

The nature of the geographical dissemination of the ultra-abyssal benthic and bottom-dwelling fauna may be judged by that part of it for which there are already species analyses (over 660 species of Metazoa). Below are the main groups of species depending on the type of their dissemination.

Type of dissemination	% of all ultra-abyssal species
Species endemic for ultra-abyssal	56.4
Encountered only in one trench	4.7
Encountered in two or several neighboring trenches	6.4
Encountered in two or several distant trenches	3
Species encountered at lower depths	43.6
Only in the ocean region where the trench is located (in the limits of one abyssal zoogeographic province)	22
Known from different regions of one ocean	4.6
Known from two oceans	11
Known from three oceans	6
	100

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TABLE 13. COMMON NATURE OF FAUNA IN THE GREATEST DEPTHS OF THE KURIL-KAMCHATKA AND IZU-BONIN TRENCHES

As is apparent from these data, the most characteristic feature of the ultra-abyssal benthic fauna in relation to its geographical dissemination is the dominance in it of species that are only confined to certain local regions of one ocean. Among the ultra-abyssal endemics there is a strong dominance of species that are endemic only for one trench or for a group of neighboring trenches (about 95% of the ultra-abyssal endemics, or 53.5% of all the ultra-abyssal fauna), while among the animals with vertical distribution exceeding the ultra-abyssal zone, half are species in the ocean region where the trench is located in which these species are found below 6,000 m. Three-fourths of all the trench fauna are thus species with local dissemination within some one abyssal province per the Vinogradovich system.

At the same time, based on the considerable isolation of the trench fauna from the abyssal regions of the ocean floor adjoining the trenches as expressed in the high degree of endemism on the species level, it is advisable to isolate different trenches or groups of neighboring trenches into independent zoogeographical units of the province rank into one system of zoogeographical zoning of ocean depths (abysssal and ultra-abyssal) [Beliaev, 1972, 1974a; Beliaev, Vinogradova, 1977; Vinogradova, 1977; Vinogradova, 1979].

A significant fauna similarity was found between the group of trenches forming a single chain, Aleutian, Kuril-Kamchatka, Japan and Izu-Bonin. Of the 276 species defined from this group, 26% are species that are common for two, three or all four of these trenches. The ultra-abyssal endemics in the fauna of each of these trenches comprise from 42 to 53% (see Table 8), while the total endemism of the fauna of all four trenches is 51%. Among the non-endemic species (known from depths below 6 km), over half are known only from the Pacific Ocean, and 46% only from the North Pacific abyssal province per the Vinogradova system.

A comparison of the population of the deepest regions (depths over 8 km) in the Kuril-Kamchatka and Izu-Bonin trenches,currently separated by shallower sections of the Japan trench (Table 13) shows interesting results.

As is apparent from Table 13, among the endemics of these two trenches there is a common species (E. birsteini), whose population individuals from these trenches do not differ morphologically; there are different subspecies of one species (E. hanseni) and close species of the same genera. None of these species have been found beyond the examined trenches, included in the Japan trench. We thus see

Таблица 13

Общность фаун наибольших глубин Курило-Камчатского и Идзу-Бонинского желобов

Вид SPECIES	Глубина обитания, м (число нахождений) DWELLING DEPTH, M (NUMBER OF FINDINGS)	
	KURIL-KAMCHATKA Курило-Камчатский	IZU-BONIN Идзу-Бонинский
Elpidia birsteini	8060–9345 (6)	8530–8540 (1)
Elpidia hanseni hanseni	8610–9530 (8)	–
E. h. idsubonensis	–	8800–9735 (3)
Parayoldiella ultraabyssalis	8355–9530 (5)	–
P. idsubonini	–	8800–8900 (2)
Bathycrinus sp. B	8175–9345 (5)	–
Bathycrinus sp. F	–	9715–9735 (1)
Heptabrachia abyssicola	6475–8100 (2)	–
H. subtilis	–	9715–9735 (1)

Как видно из приведенных данных, наиболее характерной чертой ультраабиссальной донной фауны в отношении ее географического распространения является преобладание в ней видов, приуроченных только к определенным локальным районам одного океана. Среди эндемиков ультраабиссали резко преобладают виды, эндемичные лишь для одного желоба или для группы соседних желобов (около 95% ультраабиссальных эндемиков, или 53,5% всей ультраабиссальной фауны), а среди животных с вертикальным распространением, выходящим за пределы ультраабиссальной зоны, половину составляют виды, распространенные в том районе океана, где находится желоб, в котором эти виды найдены глубже 6000 м. Таким образом, три четверти всей фауны желобов составляют виды с локальным распространением в пределах какой-либо одной абиссальной провинции по схеме Виноградовой.

Вместе с тем на основе значительной обособленности фауны желобов от прилегающих к желобам абиссальных районов ложа океана, выражающейся в высокой степени ее эндемизма на видовом уровне, представляется целесообразным выделять разные желоба или группы соседних желобов в самостоятельные зоогеографические единицы ранга провинций в единой схеме зоогеографического районирования океанических глубин (абиссали и ультраабиссали) [Беляев, 1972, 1974а; Беляев, Виноградова, 1977; Виноградова, 1977; Vinogradova, 1979].

Значительное фаунистическое сходство обнаруживается между группой образующих единую цепочку желобов – Алеутским, Курило-Камчатским, Японским и Идзу-Бонинским. Из определенных из этой группы желобов 276 видов 26% составляют виды, общие для двух, трех или всех четырех этих желобов. Ультраабиссальные эндемики составляют в фауне каждого из этих желобов от 42 до 53% (см. табл. 8), а суммарный эндемизм фауны всех четырех желобов составляет 51%. Среди неэндемичных видов (известных с глубин менее 6 км) более половины известны только из Тихого океана, а 46% – только из Северо-Пацифической абиссальной провинции, по схеме Виноградовой.

Интересные результаты дает сравнение населения наиболее глубоководных районов (глубины более 8 км) Курило-Камчатского и Идзу-Бонинского желобов, разобщенных ныне менее глубокими участками Японского желоба (табл. 13).

Как видно из табл. 13, среди эндемиков этих двух желобов есть общий вид (E. birsteini), особи популяций которого из этих желобов морфологически не различаются, есть разные подвиды одного вида (E. hanseni) и близкие виды одних и тех же родов. Все эти виды не найдены за пределами рассматриваемых желобов, в том числе и в Японском желобе. Таким образом, мы видим здесь различные этапы видовой дивергенции, как бы процесс видообразования "in statu nascendi". Это позволяет предполагать, что все три желоба возникли как единое образование, в котором глубины более 8 км

different stages in the species divergence, as though the process of species formation "in statu nascendi". This allows the hypothesis that all three trenches emerged as one formation, in which depths over 8 km

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Figure 56. Combined System of Zoogeographical Zoning of Abyssal and Ultra-Abyssal

Key:
1. Regional boundaries
2. Subregions
3. Abyssal provinces
4. Ultra-abyssal provinces; the other explanations are in the text (abyssal zoning per: [Vinogradova, 1959], ultra-abyssal zoning per [Beliaev, 1974])

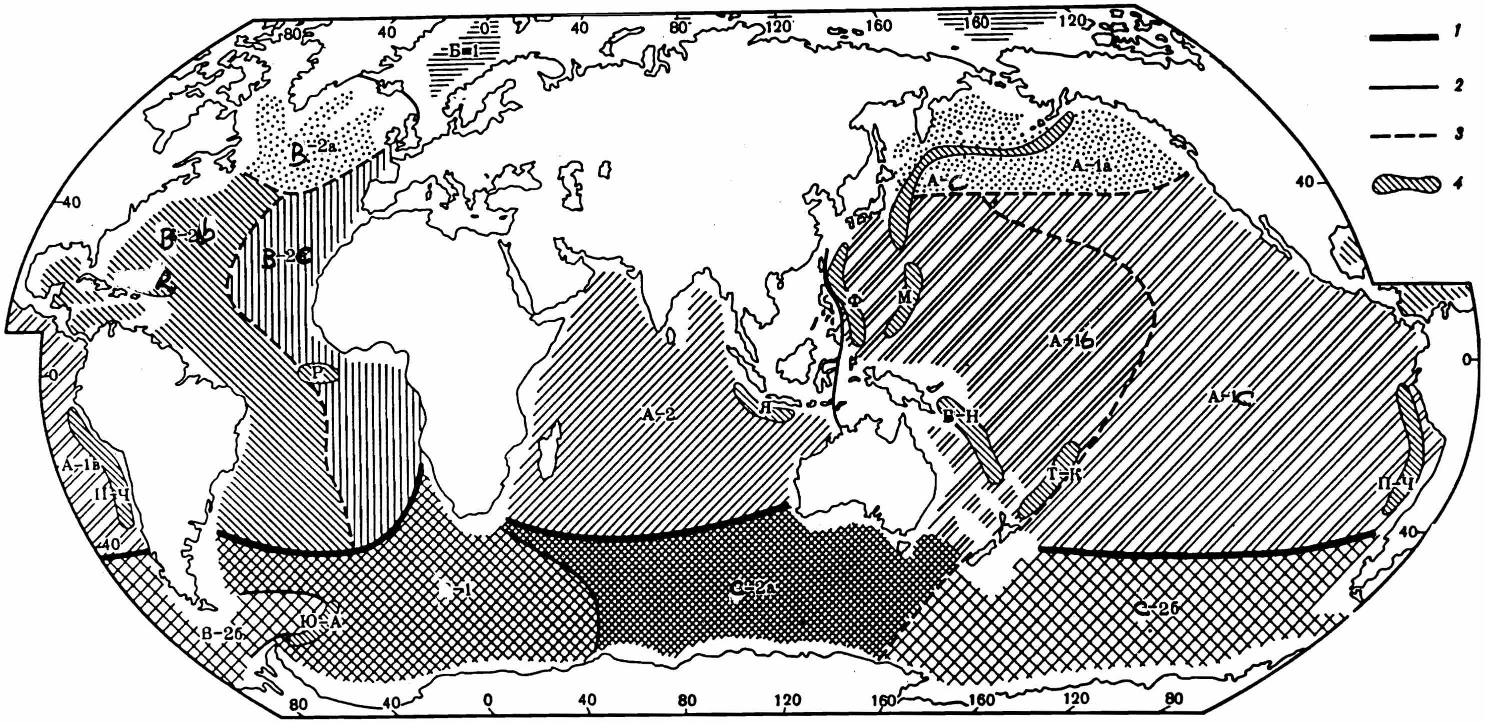

Рис. 56. Объединенная схема зоогеографического районирования абиссали и ультраабиссали

1 – границы областей; *2* – подобластей; *3* – абиссальных провинций; *4* – ультраабиссальных провинций; остальные объяснения в тексте (районирование абиссали по: [Виноградова, 1959], ультраабиссали по: [Беляев, 1974])

P'|34

were initially continuous. Their separation should have occurred only recently, most likely in the Quaternary, probably, because of the more rapid rate of sedimentation in the Japan trench due to very high seismic activity in the area of this trench.

Judging from the presence of a number of endemic ultra-abyssal species common for the Aleutian and Kuril-Kamchatka trenches (9 species, of which 5 dwell also in the Japan trench), these trenches were also previously combined at depths over 6.5-7 km, while the currently existing threshold between them from depth about 5.5 km developed only recently, and the now separated populations that are common for these trenches of ultra-abyssal endemics did not successfully diverge into independent species, and in only one case, are represented by different subspecies of one species (Isopoda Storthyngura tenuispinis).

The fauna links found between the currently isolated greatest depths in the Tonga and Kermadec trenches (two new Bivalvia species analyzed by Z. A. Filatova, caught in these trenches at depths 9-10.5 km but still not described) apparently indicate the existence of a previous indirect link between these depths, i.e., the emergence in these trenches of a unit and the only recent (in a geological sense) formation between them of a threshold with depth slightly over 6,000 m.

Asteroidea, Lethmaster rhipidophorus, belonging to the subfamily, genus and species endemic for the ultra-abyssal and dwelling at depths from 6,460 to 7,880 m have only been found in the Ryukyu and Philippine trenches. This allows the hypothesis that trenches there were previously united by depths over 6 km, possibly through the greatest depths of the Philippine trough in which there are now numerous depressions with depths on the order of 6-7 km (see Fig. 5).

Fairly numerous fauna links have also been found between a group of trenches that forms a single chain: Volcano-Mariana-Yap-Palau, which apparently is also linked to the common origin of these trenches. Thus, for example, all 12 of the species known from the Mariana trench are endemic for the ultra-abyssal, but 6 of them were also found in neighboring trenches. In several cases, there are also known ultra-absyssal endemics that are common for the Mariana and Philippine trench groups.

It is more difficult to explain the existence of species endemic for depths over 6 km that are common for two or a greater number of very separated trenches. There are 20 known species which have this dissemination; 7 of them are crustaceans from the order Amphipoda which lead an active-mobile lifestyle mainly at the floor, but apparently are capable of also rising considerable distances above the bottom. It is not excluded that some representatives of these species could sometimes rise to depths somewhat less than 6 km, although they have not yet been caught at these depths. The other, although less likely explanation for the dissemination of these species in very separated trenches is their comparatively recent settlement of the ultra-abyssal depths in various parts of the ocean and their parallel evolution in different trenches from the common widespread, less deep-sea predecessor. In some cases, when we are dealing with dissemination of sedentary forms (e.g., finding only in the Kuril-Kamchatka and Tonga trenches of the Bonus petrochenkoi Gastropoda or the Polychaeta Bathykermadeca hadalis disseminated in five separated trenches), we should possibly look for an explanation in the fact that the populations from different trenches belong to different biological species that are indistinguishable at the morphological level which is accessible for study.

Sometimes, the explanation of instances of such a questionable dissemination may be simply the lack of study of the fauna in the abyssal ocean depths, as in the Actinia Galatheantemiidae for which it was recently clarified that they not only dwell in almost all the trenches, but are also widespread at depths over 4 km in the Antarctic and subAntarctic waters.

Based on a generalization of the data regarding the geological dissemination of the trench fauna, it was suggested that the system of zoogeographical zoning be supplemented for the abyssal, developed by N. G. Vinogradova, by isolation of the ultra-absyssal provinces (Fig. 56), as a result of which this system has the following appearance [Beliaev, 1974; Vinogradova, 1977; Vinogradova, 1979].

A--Pacific Ocean-North Indian deep-sea region

A-1--Pacific Ocean subregion [provinces-abyssal: A-1a-North Pacific Ocean, A-1b-West Pacific Ocean, A-1c-East Pacific Ocean; ultra-abyssal: Al-Jap-Aleutian-Japan (Aleutian, Kuril-Kamchatka, Japan, Izu-Bonin Trenches), PLP-Philippine (Philippine and Ryukyu trenches), M-Mariana (trenches: Volcano, Mariana, Yap, Palau)[1], BG-NH-Bougainville-New Hebrides (trenches: New Britain,Bougainville, Santa Cruz, New Hebrides, Ton-Kep-Tonga-Kermadec, P-Ch-Peru-Chile]

A-2--North Indian subregion (Y-Yavan ultra-abyssal province)

B--Atlantic deep-sea region

B-2--Atlantic subregion (provinces-abyssal: B-2a-North Atlantic, B-2b-West Atlantic, B-2c-East Atlantic; ultra-abyssal: PR-Puerto Rico; R-Romanche)

C--Antarctic deep-sea region

C-1--Antarctic-Atlantic subregion (S-A--Southern Antilles ultra-abyssal province)

C-2--Antarctic-Indian-Pacific Ocean subregion (abyssal provinces: C-2a--Indian, C-2b--Pacific Ocean).

It is possible that this system will have to be supplemented in the future after isolation into separate ultra-abyssal provinces of the Banda and Cayman trenches after a more complete study of their fauna.

It is not expedient to assign a zoogeographical status (including the Hjort trench) to individual provinces based on individual submersions with depths somewhat over 6 km in various ocean troughs, since their fauna differs only slightly from the abyssal fauna of the neighboring ocean regions, and its endemism at the species level is from 20 to 28% (see Table 8).

Chapter 9

ECOLOGICAL GROUPINGS AND BIOLOGICAL FEATURES OF TRENCH BENTHIC FAUNA

ECOLOGICAL GROUPINGS

The basis for characterizing the ecological groupings (biocenoses, communities) of the benthic fauna of shallow depths is usually the quantitative bottom drag collections, supplemented by data from trawling catches. At the ocean depths where the fauna are much sparser than on the shelf, in the latter the macro- and mega-benthos are considerably thinner and the bottom grabs do not provide a correct idea about the composition of the benthic population or the relative role of individual species, the taxonomic and ecological fauna groups.

The quantitative methods developed for the biocenotic characterization of the shelf fauna [Zenkevitch, Brotskaya, 1937; Brotskaya, Zenkevitch, 1939; and subsequent works of other authors], cannot be used to study the biocenoses of hadal ocean depths. The nature of the benthic biocenoses of the deep-sea fauna has to be judged mainly from the relative role of different species and groups in the trawling hauls. These catches, obtained from comparatively shallow and uniform sections of the floor, could reflect more or less correctly the main composition of the community. However, when the trawling occurs at a considerable distance and encompasses a section with complex floor reflief or great range of depths (sometimes hundreds of meters), as often occurs in work in the trenches, fauna of varying communities are represented in one haul.

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[1] It is not excluded that as a result of further study of the fauna in the trenches surrounding the Philippine Sea, it will be expedient to combine the ultra-abyssal Philippine and Mariana provinces.

The nature of benthic communities in the trenches may be judged to a certain measure also from the photographs of the floor, but mass photographs of the floor have only been obtained in a few tropical trenches [Lemche et al., 1976], and they may only be used sometimes for a comparative biocenotic analysis. Thus, for example, in the Santa Cruz trench at depth 8,700-8,900 m, close to the greatest depth of this trench, one of the photographs detected no less than 15 specimens of Actinia attached to the detritus lying on the floor. No other animals were found in this photograph, which indicates the existence here of a local biocenosis consisting of one or two species of Actinia. Other photographs obtained in the same depth interval of this trench and covering sections with soft silt, also did not reveal more than 2-4 species of animals (apparently two species of Polychaeta, traces of Holothurioidea Pseudostichopus {?) and some other animal).

The observations and collections made during submersions of underwater research vessels provide an exceptional opportunity for studying the benthic communities. These methods that are widely used, for example, in studies of underwater hydrothermal regions by the American, French and Soviet expeditions, permitted an extremely more detailed clarification of not only the composition, but also the details of distribution of the hydothermal fauna communities. However, study by these methods of life at depths over 6 km is a matter for the future. Other methods for studying benthic trench communities have not yet been developed. This also explains the still extremely insufficient degree of study of the trench benthic fauna communities.

L. A. Zenkevitch and Z. A Filatova [1958], in characterizing the biocenoses of the benthic fauna of different depths in the northwest Pacific Ocean, believed that for depths 6-9 km of the Aleutian, Kuril-Kamchatka and northern Japan trench, there is a typical single community of Holothurioidia of the genus Elpidia, Pogonophora, Echiuroidea and representatives of two genera of Polychatae. However, as indiciated by further research this is an unqualified unified characterization for the entire range of trench depths, as well as for their slopes and its flat bottom extending along the trench axis.

The series of publications of M. Sokolova [1956, 1960, 1964, 1965; et al.] that mainly covered the abyssal depths, made a more detailed development of this topic. Based on an analysis of the composition of the fauna in the trawling hauls obtained from different depths in the northern Pacific Ocean, Sokolova isolates different trophic types of benthic biocenoses whose distribution on the floor is determined by the natural bottom relief changes with depth and the related distribution and quantity of organic detritus in the bottom water layers, on the sediment surface, and in its mass. In the example of the northwest Pacific Ocean and the Kuril-Kamchatka trench, Sokolova [1960] revealed the existence of vertical zonality in the biocenoses distribution of different trophic types and proposed a system of their repeated alternation as the depth increases and related changes in the bottom relief.

The vertical trophic zonality proposed by Sokolova is mainly applicable to the continental slope and the adjoining abyssal depths. As for the trenches, the natural alternation of tophic zones could only exist in them in cases where certain forms of the relief are extended a considerable distance along the trench and are repeated at different depths. However, the trench slope relief is usually more complicated. The slope sections that are confined to the most pronounced bends of the least sedimentation, as well as the outcroppings of solid rock that are numerous on the slopes where sedimentation does not occur at all [Bezrukov, 1970] could be located in trenches without a certain pattern.

Therefore as applied to the trenches, it can be stated that it is not so much the correct alternation of the trophic zones on the vertical, as the local confinement of the biocenoses of different trophic types to certain forms of the relief and the related conditions of sedimentation, as well as the ocean regions that vary in trophic conditions.

Differences are more clearly expressed in the types of benthic biocenoses between the trench slopes and their flat bottom extended along the trench axis. The latter is characterized by fine-grained muddy sediments, considerable rates of sedimentation and high content in the sediment of organic matter (especially in the ocean eutrophic region trenches). In the direction from the greatest depths in the central trench sections to their terminal sections, there is usually a fairly gradual increase in depth, an ocean flor gently sloping more towards the depths than on the trench side slopes. The trophic conditions here that are characteristic for the floor of this trench (depending on the degree of eutrophicity or oligotrophicity of the region where this trench is located) are preserved at different depths. Thus, for example, in the southern Kermadec trench, the typical community for the floor of different trenches with severe dominance of Holothurioidea of the genus Elpidia was found at the trench axis at depth 8,200-8,300 m with considerably lower population than at the greatest depths in its central section.

Usually the dominant and most mass components of the fauna on the floor of the trench axis are detritus-eating Holothurioidea, primarily of the family Elpidiidae, and in particular, the genus Elpidia represented in the majority of trenches, as well as the family Myriotrochidae and some others. While the trophic uniformity of biocenoses of the trench axis floor is maintained, the taxonomic composition of the animals dwelling here changes depending on the depth and location of the trench.

R. Menzies and R. George [1976], based on the fact that there are ocean floor sections that do not reach depth 6 km, but have morphological trench features (in relation to the steep slopes and narrow flat bottom extended along the longitudinal axis), suggested for the population of the bottom of such morphologically similar structures, regardless of their depths, the name "trench floor fauna" instead of the names "ultra-abyssal" or "hadal fauna". A detailed and convincing critique of this suggestion was already given in the publication of T. Wolff [1970]. It should only be noted here that the conclusions of Menzies and George do not have any relationship to vertical zonality, henceforth, the name "trench floor fauna" may not be contrasted to the names used to designate depths over 6 km in the system of vertical biological zonality of the ocean. Menzies and George, however, are quite correct in noting the ecological similarity of the population of the flat bottom filled with soft sediment of the ultra-abyssal (hadal) trenches and similar morphological structures in the less deep-sea regions. In this ecological sense, the name "trench floor fauna" was justified by the stipulation that this fauna which has a similar ecological appearance at different depths will differ not only in taxonomic composition of the animals, but also in their diversity.

As for the benthic screener representatives of the epifauna (Spongia, many Coelenterata, Crinoidea, Pogonophora and Ascidea), there are usually few of them in the trenches and they are confined to the local rock outcroppings, mainly on the trench slopes, and sometimes to fragments of these rocks that are carried to the trench floor. In the trawling hauls obtained in the trenches, they are massive only in single cases (numerous Pogonophora at depth 9 km and Crinoidea at depths 8,200-9,000 m in the Kuril-Kamchatka trench, Hyalospongia on the slopes of the South Sandwich trench at depths about 6,800-7,200 m).

As shown above (see Table 12), the number of species in the trawling hauls from the trenches diminishes as the depth increases. In other words, there is a rise with depth in the oligomictic nature of the biocenoses. The trawling catches from depths over 6 km are characterized in general by the dominance of one, sometimes, two-three species that comprise the background of the entire catch. But this dominance was expressed most clearly in the catches obtained from the greatest depths, especially in the mass hauls from the hadal depths of the eutrophic trenches.

The degree of domination of one-three dominant species increases with depth simultaneously with the rise in the oligomictic nature of the biocenoses. At the hadal depths of the eutrophic trenches, the population of one dominant species in the benthic biocenosis (usually Holothurioidea of the Elpidia genus) often reaches several thousand individuals in one trawling catch and could comprise up to 98% of the total population of the caught animals. It is precisely under these conditions that the extreme specific nature of the existence conditions for the pressure factor is combined with the trophic capabilities that are fairly favorable for the mass development of the species that are adapted for these conditions.

A. Thienemann [1918] formulated a general law, according to which, the more that the biotype living conditions differ from the normal and optimal for the majority of organisms, the fewer species are in the biocenosis and the more individuals there are in individual species. A. A. Shorygin [1955] came to the same conclusions, according to which the monocenoses that represent an extreme case of oligomictic nature, may only be encountered in the biotypes that deviate the most from the norm.

I previously [1966b] noted the correspondence to this law of the conditions at critical trench depths. Later research of trench fauna confirmed this correspondence to a greater measure. A clear example of monocenosis is the existence and mass development of the only active-mobile bottom-dwelling species, scavenger, Amphipoda Hirondellea gigas at the greatest depths of the Philippine and Mariana trenches [Hessler et al., 1978].

SOME BIOLOGICAL FEATURES

There are no external differences between the animals living below 6 km and the dwelling at somewhat lower depths in the lower part of the abyssal zone. There are no known specific conditions for the ultra-abyssal depths, with the exception of high hydrostatic pressure. The adaptations to the constant existence at extremely high pressures are apparently expressed at physiological and biochemical levels and do not require morphologically pronounced changes in the organism.

Due to the total lack of light, not only at trench depths, but also in the abyssal zone, the body coloring here may not have an adaptive value for the benthic animals, and among them there is a dominance of organisms that do not have pigmentation [Zenkevitch, Birstein, 1955; Zenkevitch, Birstein, 1956]. However, the coloring of many species is preserved even at such depths, green in some Echiuroidea [Zenkevitch, 1958], light-yellow in Crinoidea Bathycrinus [Beliaev, 1966b], lilac or violet in some species of Polychaetae of the family Polynoidae [Ushchakov, 1955; Levenstein, 1971]. All Pogonophora, including the hadal species, have red blood due to the presence of hemoglobin [Ivanov, 1960a; Ivanov, 1963]. The body of the ultra-abyssal fish Careproctus amblystomposis is pinkish [Andriashev, 1955]. The only known specimen of the ultra-abyssal trachomedusae Voragonema profundicola with oral trunk was brown [Naumov, 1971], while orange was noted on a color photograph of antomedusae obtained at depth 8,260 m [Lemche et al., 1976].

The overwhelming majority of ultra-abyssal animals do not have eyes. But some Crustacea and Gastropoda representatives, even those living at such depths, do retain rudiments of eyes that do not have a functional value [Wolff, 1956a, 1962; Birstein, Chindonova, 1958; Bacescu, 1971; Zharkova, 1975, 1978]. Two species of Isopoda of the eurybathic genus Antarcturus, dwelling below 6 km, maintained externally normally developed eyes [Birstein, 1963a; Kussakin, 1971], which probably indicates the comparatively recent settlement of the great depths by representatives of this genus. Of the known fish from the ultra-abyssal eyes have also been preserved [Andriashev. 1955; Munk, 1964], but compared to the eyes of the shallower representatives of the same genera they are either very small, or it has been established that they are in a degenerative state [Rass, 1964, 1974].

For a number of known deep-sea animals there is a known phenomenon of so-called deep-sea rachitism that is expressed as a thinning and reduced degree of calcification of the skeletal formations. This phenomenon is linked to a deficit of calcium carbonate below the critical (compensation) depth (usually between 4,000 and 5,000 m), where the water is undersaturated with calcium carbonate and its content in the sediment is negligible. It is natural that for the benthic animals dwelling at these depths, the removal from the bottom water and benthic sediment of calcium carbonate that is necessary for skeletal development is extremely difficult. Additionally, they have the constant problem of actively maintaining and renewing the skeletal formations in spite of the active gradient aimed at their dissolution. However, this refers equally to the denizens of the lower abyssal and hadal. There is no doubt that this is linked precisely to the drastic reduction at these depths of the number of species and the quantity of Foraminifera with calcareous shell, the absence here of calcareous Spongia and the skeletal weakening of some deep-sea mollusks, brachiopods and some other animals.

F. A. Pasternak [1970] notes that the skeletal formations of a number of ultra-abyssal Pennatularia are reduced more severely than those of the abyssal. However, this refers to the representatives of the populations that are only found at 100-200 m below 6 km, and therefore may be considered specific for the real ultra-abyssal depths. Ya. A. Birstein [1963a] indicates that the shells of two ultra-abyssal Isopoda (Eurycope magna and Storthyngura vitjazi) are thinner than the shallower species of the same genera. However, even among the Isopoda there is a known stronger skeletal development in the ultra-abyssal species (S. herculea [Birstein, 1957]. The same is known from a number of Tanaidacea [Wolff, 1956b].

Numerous other examples could be cited of the fact that in trenches all the way to their greatest depths, many animals cope successfully with the problem of skeletal structure of which they have a no less developed one than their shallower relatives. This refers, for example, to some Bivalvia and Gastropoda, Asteroidea of the family Porcellanasteridae, Crinoidea of the genus Bathycrinus, Ophiuroidea of the genus Abyssura. All the ultra-abyssal species of Holothurioidea of the genus Elpidia have numerous calcicareous spicules that are larger and coarser than those of the abyssal, and they are the most massive and numerous among the deepest sea species, E. hanseni that lives at depths to 9,700 m. In this respect, there are thus no specific differences between the abyssal and hadal animals.

Yet another characteristic feature for some benthic invertebrates is the tendency towards increased body dimensions as the habitat depth increases. This phenomenon which has been called deep-sea gigantism was noted for several representatives of some orders of Crustacea [Zenkevitch, Birstein, 1955; Zenkevitch, Birstein, 1956; Wolff, 1956, a, b, 1960, 1962, 1964, 1970; Birstein, 1957, 1963a, 1971b; Birstein, Chindonova, 1958; Jones, 1969]. It should be stipulated that all the authors who have noted this phenomenon meant by deep-sea gigantism a relative increase in the body dimensions with depth in some deep-sea (especially ultra-abyssal) animals compared to their related inhabitants of shallower depths (within the genus or family, and in one case, even the order, Tanaidacea). Therefore, as noted by T. Wolff, it is more correct to speak not of gigantism as such, but namely a tendency towards larger dimensions [Wolff, 1962, p. 287] or to use the term "gigantism" in quotation marks. This is an important stipulation insofar as the use of the name deep-sea gigantism in some cases resulted in the fact that an argument against the existence of this phenomenon cited examples of the existence of the largest animals within the orders or classes that did not have a relationship to it in the shallows or even on dry land [Madsen, 1961b; Menzies, George, 1967].

The most numerous examples of increased sizes with depth and the greatest dimensions of ultra-abyssal species are known among the many Isopoda genera of the suborder Asellota. The ultra-abyssal species A. magna has the greatest dimensions among the Amblyops genus. An increase in body dimension with depth was also observed in some Cumacea genera. Until comparatively recently, the largest in the order Tanaidacea was considered the ultra-abyssal species Herpotanais kirkegaardi described by T. Wolff. But in 1978, R. K. Kudinova-Pasternak described a considerably larger species Gigantapseudes adactylus from the ultra-abyssal Philippine trench which was yet another confirmation of the law under discussion. However, soon [Gamo, 1984] an even larger species, G. maximus (length up to 75 mm) was described from a shallower depth, about 5.5 km. The largest representatives of the order Amphipoda (length 282 mm) were also found at depth 5,300 m [Hessler et al., 1972]. The dimensions of these Amphipoda are much greater than the dimensions of all the ultra-abyssal species of this order.

Among the animals of other taxonomic groups, one can note only single examples of deep-sea "gigantism". Comparison of the data of A. V. Ivanov [1960a] regarding the body dimensions of various Pogonophora indicates that the dimensions of the ultra-abyssal species of the genera Spirobrachia, Heptabrachia and Diplobrachia are larger than the shallower species of the same genera. Among the Holothurioidea of the genus Elpidia [Beliaev, 1971b, 1975] the dimensions of numerous ultra-abyssal species are larger than the abyssal, but are similar to the dimensions of shallower Arctic and Antarctic species.

There are no other known examples of "gigantism" among the ultra-abyssal animals, and sometimes the opposite correlations are observed. T. S. Rass [1974] regarding fish noted that "the adult hadal species are smaller than the close abyssal species" (p. 210).

I. S. Zharkova [1968] studied the change in the number and size of intestinal cells of some abyssal and hadal species of Isopoda. It was found that each species (and sometimes close species and even genera) is characterized by a more or less constant number of cells, but the increase in body dimensions in ontogenesis is due to the increased cell size. It is important that the increase in body size of hadal Isopoda species, based on Zharkova's data, is also mainly due to the increased cell size. These data agree with the assumption that the increased body size of deep-sea Isopoda is due to the longer life span under these conditions [Wolff, 1962].

The possible reasons for the increased body size with depth and the greatest dimensions of ultra-abyssal representatives of different Crustacea genera have been discussed repeatedly by T. Wolff and Ya. A Birstein who established this phenomenon, as well as R. Menzies et al. [Menzies, George, 1967; Menzies et al., 1973]. Insofar as the increase in dimensions in some cases occurs in closely related species of the Crustacea genus (as well as Holothurioidea of the Elpidia genus) at comparatively shallow depths in the polar regions and is related to low temperature, while in other cases, is related to great depths and within these depths does not depend on temperature, then we must hypothesize the effect of hydrostatic pressure, and most likely the effect of "gigantism" in the ultra-abyssal depths is due to the summary impact of both of these factors. But the biological essence of the mechanisms for this effect still remains unclear, which is why "gigantism" is manifest selectively only in some representatives of a few taxonomic animal groups.

All the abyssal and hadal animals are characterized by the absence in their body of any gas-filled cavities. All the body cavities are only filled with fluids that mechanically results in a balancing of internal pressure with the external pressure without energy expenditures, and because of the essential incompressibility of the fluids do not threaten the animals with enormous crushing external pressure. However, there is a known case of preservation of a small air bladder in a hadal fish Hacomycteronus profundissimus that has not been found at depths less than 5 km [Nielsen, Munk, 1964]. The functionining mechanism of this organ under such high pressure conditions is not known.

Chapter 10

HYDROSTATIC PRESSURE AS AN ECOLOGICAL FACTOR

A review of all the available data on the ultra-abyssal benthic fauna leads to the conclusion that there is an extreme specific nature in the existance at depths over 6 km and an increase in this specificity with depth as the maximum ocean depths are reached.

I have already noted above that based on such factors as temperature, salinity, oxygen-saturation of the water, and nature of the soil, the ultra-abyssal depths do not differ significantly from the abyssal ocean floor depths adjoining the trenches, and even the shallower regions. As for the feeding conditions, in the trenches they are generally more favorable for the benthic fauna than on the ocean floor in the regions neighboring the trenches, and thus, may also not have a limiting effect upon it. The high seismic activity in the trench regions could result in the local and frequent death of animals as a result of slides and avalanches, but may not affect the actual possibility of settlement of the ultra-abyssal depths.

The only factor that we know about is that it changes in parallel and in one direction with depth, and as it increases in the ultra-abyssal zone it deviates more and more from the form for the overwhelming majority of marine animals, and that is hydrostatic pressure. We do not know of any other such factors, not to mention some indicators that in themselves are the function of pressure.

It is known that some physical properties of solutions depend on hydrostatic pressure. High pressures affect solution viscosity, ionic equlibrium, its related conductance of solutions [Gonikberg, 1960] and gas solubility [Klots, 1961]. It is possible that high pressure impacts on any other properties of seawater and through these changes affects the living organisms.

No direct experiments have yet been made on the physiological effect of pressure on ultra-abyssal animals. Setting up of these experiments requires development of methods of catching animals, lifting them to the surface and then keeping them while maintaining the pressure inherent to their natural habitat, as well as possible experimental change in this pressure and observation of its results. At ocean floor depths, these isobaric traps lowered on autonomous instrument-carriers have already been used for small benthic animals [Macdonald, Gilchrist, 1982]. Experimental samples of these isobaric traps for ultra-abyssal depths have already been developed [Anonym., 1977; Yayanos, 1977], and their use for experimental research may yield extremely important results.

Because the ultra-abyssal animals do not have gas-filled cavities, the volume of their body essentially remains unchanged when the pressure changes, and when raised to the surface, they may appear externally undamaged. However, insofar as one can judge from their total lack of mobility, they do not withstand the rapid decrease in pressure from 600 atm and more to normal atmospheric pressure.

It was experimentally established in relation to many shallow organisms that a strong increase in pressure proves fatal [Fontain, 1930; Ebbecke, 1935; ZoBell, Oppenheimer, 1950; Oppenheimer, ZoBell, 1952; ZoBell, Morita, 1959; Menzies, Wilson, 1961; et al.]. There are numerous experimental data on the effects from pressure on the order of several hundreds of atmospheres on different biological processes occurring in the cells and tissues of organisms existing under natural conditions at normal atmospheric pressure: on the rate of many biochemical reactions, on the enzymatic processes, energy exchange processes, motor activity, cellular growth and division, and mutation frequency.

The summary of A. A. Shulyndin [1967], as well as a number of survey articles of other authors [Schlieper, 1963, a, b; 1966, 1968; Kal'kar, 1964; Menzies, 1974; Schlieper, Tide, 1975; et al] cover a detailed examination of various aspects of the effect of high hydrostatic pressure on biological creatures on the organism, tissue, cellular and biochemical levels.

In discussing the biological effects of high pressure, G. Kal'kar [1964] advances the hypothesis: "Hydrostatic pressure may have a strong impact on the equilibrium between single-strand and double-strand DNA" (p. 395), as well as on the complex mechanism of protein synthesis that is concentrated in the submicroscopic particles, the ribosomes.

All of these data allow us to hypothesize that even under natural conditions, high pressures, on the one hand, should require special adaptations from the animals that have adapted to them, and on the other hand, limits the actual possibility of adaptation to them of many animals, acting as a screening factor. This hypothesis agrees well with the aforementioned data about the increase in the specific nature of the ultra-abyssal fauna as the depth increases, about the decrease in the number of species with depth, and about the gradual loss from the fauna composition of the large taxonomic groups.

The opinion has been stated repeatedly that there is a great probability of a direct physiological and ecological effect of hydrostatic pressure on the ocean depth dwellers, and as far as I know, is adopted by the majority of researchers of the deep-sea ocean fauna. These viewpoints were recently confirmed by experimental studies on the effect of the pressure change on various deep-sea animals [Moon et al., 1971; Macdonald, Gilchrist, 1982; Mickel, Childress, 1982; et al.]. Summaries have also been published that generalize the accumulated data on the effect of high pressures on different aspects of vital activity of organisms [Barobiology…, 1972; Kriss, 1973; Macdonald, 1975]. In the introduction to the collection Barobiology, its editor R. Brauer [1972] wrote: "The existence of the effect of hydrostatic pressure on the broad diversity of biological processes is no more than a hypothesis. This is a well established fact" (p. 2).

Experiments on the impact of pressure change on Byothograea thermydron crabs living at depth about 2.5 km in the region of the Galapagos hydrothermal regions collected and brought to the surface by the research submarine Alvin demonstrated that these crabs may withstand only a brief reduction in pressure to 1 atm. The majority of crabs in this case died quickly, and none of them survived more than 5 days. Under these conditions cardiac activity disorders were observed in them. The crabs endured a double reduction in pressure compared to the normal (from 238 to 120 atm at temperature 2°C), none of the 25 specimens died in 21 days [Mickel, Childress, 1982].

Extremely interesting results were obtained by A. Macdonald and I. Gilchrist on several species of Amphipoda brought up in isobaric traps from depths somewhat over 4,000 m. With a gradual rise in pressure to 500-600 atm sometimes a slight increase in motor activity was observed in these Amphipoda; with a further rise in pressure it dropped, and at pressure 750-800 atm, motion stopped altogether. These same authors cite numerous published data on the fact that increase in pressure above a certain level in different shallow animals results in disruption in neuromuscular activity expressed as convulsive uncoordinated movements, and a further rise in pressure, results in complete paralysis. For a number of shallow Crustacea, the pressure at which convulsions occur (P_c) is from 50 to 100 atm. For benthic Amphipoda a linear increase is observed in P_c as the dwelling depth increases to 2,700 m. Increase in pressure in Amphipoda living at depth 4,000 m, as stated above, in general did not cause convulsions. Amphipoda dwelling at depth 4,000 m in their reaction to increased pressure thus differ radically

Figure 57. Dependence of Greatest Catalytic Rate of Lactate-Dehydrogenase from Coryphaenoides sp. Muscles on Pressure and Temperature
psi--pressure in pounds per 1 inch^2 (1,000 psi = 68 atm); v--velocity [per: Moon et al, 1971]

from those living at depths to 2,700 m [Macdonald, Gilchrist, 1982].

The publication of the magazine "American Zoologist" (Vol. II, No. 3) that was published in 1971 was dedicated to studies of the pressure impact mainly on the nature and rate of biochemical reactions in deep-sea Macruridae fish. The studies were made on board the research vessel Alpha-Helix (United States) in the area of the Galapagos Islands on fish that were just caught at depths to 2,400 m in traps with bait lowered to the bottom on the autonomous instrument-carrier [Phleger, Soutar, 1971]. One of the articles [Moon et al., 1971] cites data on the impact of the change in pressure and temperature on the catalytic effect of lactate dehydrogenase (LDH) from the muscles of Coryphaenoides sp. (Fig. 57). As is apparent from the graph, at temperature 3°, i.e., the closest to that at great depths, the pressure change in limits from 1 to approximately 600 atm essentially does not affect the LDH activity, while a further increase in pressure lowers it severely, which is expressed as a sharp break in the curve. This could apparently serve as an indication that precisely at depth about 6,000 m there is a boundary below which a further increase in pressure could have a significant effect on the rate of biochemical reactions. It is indicative that the greatest depth from which there is a known representative of the genus Coryphaenoides is 6,180 m [Okutani, 1982].

In the monograph Biokhimicheskiye adaptatsii [Biochemical Adaptations] [Khochachka, Somero, 1988--translation from the American edition, 1984], the authors make a special discussion of the data known by 1984 on adaptations of deep-sea animals to hydrostatic pressure on physiological and

но отличаются от обитающих на глубинах до 2700 м [Macdonald, Gilchrist, 1982].

Вышедший в 1971 г. выпуск журнала "American zoologist" (Vol. 11, N 3) посвящен исследованиям влияния давления главным образом на характер и скорость биохимических реакций у глубоководных рыб макрурид. Исследования проводились на борту э/с "Альфа-Хеликс" (США) в районе Галапагосских островов на рыбах, только что пойманных на глубинах до 2400 м в ловушки с приманкой, опускаемые на дно на автономном прибороносителе [Phleger, Soutar, 1971]. В одной из статей [Moon et al., 1971] приведены данные о влиянии изменения давления и температуры на каталитическое действие лактат-дегидрогеназы (ЛДГ) из мышц Coryphaenoides sp. (рис. 57). Как видно из графика, при температуре 3°, т.е. наиболее близкой к таковой на больших глубинах, изменение давления в пределах от 1 до примерно 600 атм практически не влияет на активность ЛДГ, а дальнейшее увеличение давления резко понижает ее, что выражается в крутом переломе кривой. По-видимому, это может служить указанием на то, что именно на глубине около 6000 м проходит граница, ниже которой дальнейшее увеличение давления может оказывать существенное воздействие на скорость биохимических реакций. Показательно, что наибольшая глубина, с которой известен представитель рода Coryphaenoides, – 6180 м [Okutani, 1982].

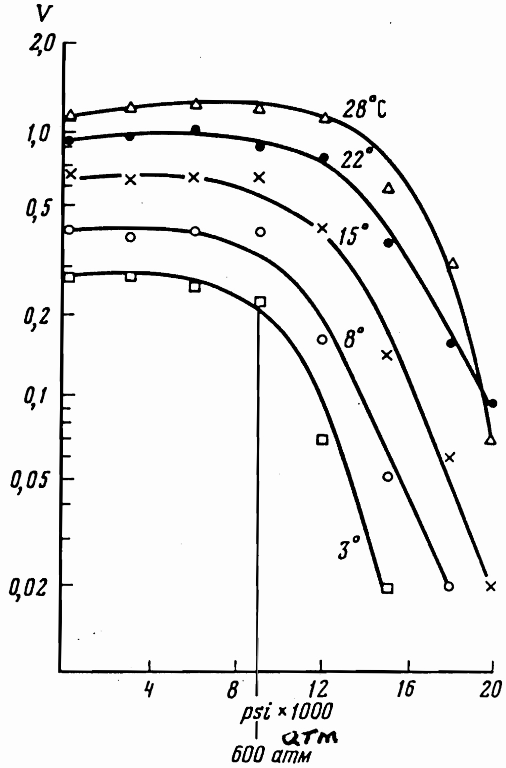

Рис. 57. Зависимость наибольшей каталитической скорости лактат-дегидрогеназы из мышц Coryphaenoides sp. от давления и температуры

psi – давление в фунтах на 1 кв. дюйм (1000 psi = 68 атм); v – скорость [по: Moon et al., 1971]

В монографии "Биохимические адаптации" [Хочачка, Сомеро, 1988 – перевод с американского издания 1984 г.] авторы специально обсуждают известные к 1984 г. данные по адаптациям глубоководных животных к гидростатическому давлению на физиологическом и биохимическом уровнях. П. Хочачка и Дж. Сомеро приходят к выводу: "Биохимические системы глубоководных животных и обитателей небольших глубин различны как в количественном, так и в качественном отношениях. Приспособительные изменения белков, благодаря которым возрастает их устойчивость к гидростатическому давлению, облегчает выживание на больших глубинах" (с. 524). К сожалению, пока

biochemical levels. P. Khochachka and Dzh. Somero conclude that: "The biochemical systems of deep-sea animals and shallow-dwellers differ both in quantitative and qualitative respects. The adaptive changes in proteins which increase their resistance to hydrostatic pressure facilitate survival at great depths (p. 524). Unfortunately,

Figure 58. Deep-Sea Manned Apparatus Mir Operating at Depths to 6,000 m.
Photograph from time of descent into water from support vessel Akademik Mstislav Keldysh

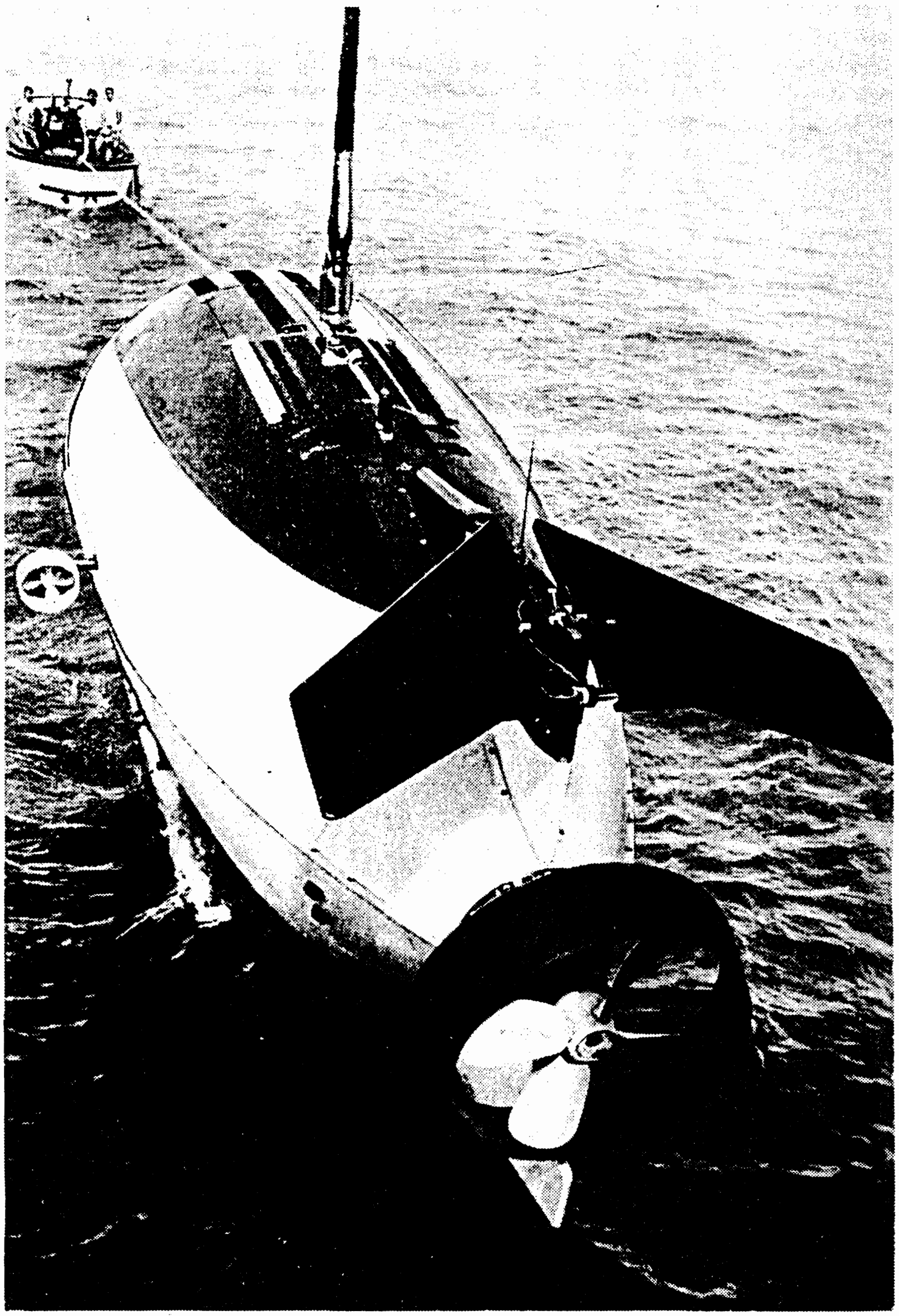

Рис. 58. Глубоководный обитаемый аппарат "Мир", работающий на глубинах до 6000 м. Снимок сделан в момент спуска на воду с обеспечивающего судна "Академик Мстислав Келдыш"

these data have been obtained exclusively for pelagic animals, mainly for fish dwelling at depths to 3-4 km. However, the biochemical specific nature of the inhabitants of the hadal ocean depths obviously should be expressed to an even greater measure.

I would like to conclude the discussion of the role of hydrostatic pressure as an ecological factor with a quotation from a letter that I received in December, 1972 from the famous Soviet physiologist (deceased), Academician Ye. M. Kreps: "High pressure affects the rate of many enzymatic reactions, the activity of the enzyme systems, the condition of the enzyme protein macromolecules and their conformation. All vital metabolic enzyme processes are not only a reaction, but also cycles and chains of reactions. The product of one link in these chains of reactions is the substrate for the next reaction. All rates of these reactions included in the cycle are normally strictly regulated, and the cycle operates normally and smoothly. Under the impact of powerful, unfavorable factors, the impact (usually inhibiting) is stronger on one link, weaker on another, and the cycle breaks down, or ceases to operate altogether. The more complex the system, the more easily it is subject to destruction. The requirements for the biochemical systems that should 'be able' to operate under such special conditions as very high pressure are higher, and not every system, or say, the system of not every organism, will withstand this 'test'. We know that random mutations may alter the formation, structure and composition of complex protein molecules that perform important biological functions. Only those mutations are preserved that are still capable of performing these functions, the others will be eliminated by natural selection and will drop out of the genetic code. The stricter the requirements for these 'operational molelcules', the fewer the chances that random mutations will be adopted by natural selection. The requirements for the operational molecules in the ultra-abyssal are higher and strict so that they may operate under these special conditions. It follows from here that natural selection should reject the majority of mutations, that only a minority of them will be preserved, a few species, and the majority will be culled. It seems to me that this is the only argument that could substantiate the inevitable paucity of fauna and its low diversity in the ultra-abyssal".

The Soviet Union in 1988 began to use the deep-sea manned apparatus (DMA) Mir-1 and Mir-2 for research (Fig. 58)[1] that was built in Finland by SOW and under the scientific supervision of the USSR Academy of Sciences. The work supervisor, I. Ye. Mikhal'tsev [1988] reports, that the DMA Mir could be lowered to depth 6 km and move underwater at a speed up to 5 knots. The life-support system allows a 3-man crew to conduct underwater operations for up to 3.5 days. The DMA Mir has a unit for stereo-photographic studies, a color TV system and diverse equipment, including two manipulators for taking samples weighing up to 80 kg. In December 1987 this equipment was successfully tested in the Central Atlantic during which Mir-1 reached a depth of 6,170 m and Mir-2 6,120 m.

The start of the DMA Mir research opens up an outlook for direct experiments on various aspects of the impact of pressure on animals collected at depth 6,000 m while preserving the pressure of their natural habitat.

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[1] I am deeply indebted to Dr. A. M. Sagalevich, a participant in the work to design and test this equipment, for providing a photograph of the Mir DMA for publication.

Chapter 11

THE ORIGIN OF DEEP-SEA AND ULTRA-ABYSSAL FAUNA

The degree of antiquity or relative youthfulness of the deep-sea fauna has been under discussion for more than a century. Intensive and comprehensive studies of the ocean depths, including the deep-sea fauna, conducted by numerous expeditions, starting from the middle of this century, have greatly increased our knowledge about the ocean's geological history, and radically altered our concepts about the nature of the World Ocean bottom, conditions of existence at great depths, the composition, dissemination and ecological features of the deep-sea fauna. This information accumulation again led to a lively discussion and polemics on the origin of the deep-sea fauna, the time of its formation, rates of its evolution, as well as the degree of constant existence conditions in the ocean depths [Andriashev, 1953; Ekman, 1953; Bruun, 1956a, 1957; Menzies, Imbrie, 1958; Zenkevitch, Birstein, 1960; Zenkevitch, Birstein, 1961; Bruun, Wolff, 1961; Carter, 1961; Menzies et al, 1961; Madsen, 1961b; Clarke, 1962b; Parker, 1962; Birstein, 1963a, 1971a; Zenkevitch, 1969a, 1971; Knudsen, 1970; Kussakin, 1971b; Kussakin, 1973; Beliaev, 1974; Hansen, 1975; Mironov, 1986; et al.].

Two extreme viewpoints may be noted regarding the origin and age of the deep-sea fauna. According to one of them, the modern deep-sea fauna should mainly be considered young. A. Bruun [1956a, 1957] advanced the hypothesis: "The relatively sudden onset of the glacial period and cooling of the ocean deep waters to a temperature below 4°C should have been catastrophic for the fauna. Only those relatively eurybathic and eurythermal species could have survived..." [1957, p. 668]. At the same time a new settlement of the abyssal should have been started, which lasted until now. A number of other authors further stated close viewpoints to a certain measure (see, e.g., [Menzies, Imbrie, 1958; Menzies et al., 1961; Clarke, 1962b; et al.]).

According to another viewpoint, the modern deep-sea fauna to a significant measure have inherent features of deep antiquity and conservatism, while the abyssal depths should be viewed as refugees that have maintained slightly altered, ancient, archaic forms [Zenkevitch, Birstein, 1960; Zenkevitch, Birstein, 1961; Birstein, 1963a, 1971a; Zenkevitch, 1969a].

These two viewpoints are customarily considered as opposite and mutually exclusive. It seems to me, however, that this viewpoint is based significantly on some extreme polemics stated by the proponents of a certain concept, but do not fully reflect the actual essence of the different viewpoints. For example, the very categorical conclusion that ends the article of Menzies and Imbrie: "The concept of the antiquity of abyssal fauna should be rejected in favor of the concept of its relative youthfulness in a geological sense" [Menzies, Imbrie, 1958, p. 208], clearly does not agree with the statement in this same article: "One can expect the finding at any depths of organisms that have a continuous history from the Paleozoic to modern times [Ibid, p. 208].

Another example may be cited from the article of L. A. Zenkevitch and Ya. A. Birstein [1961]. The authors note "the undoubted different ages of separate elements that comprise the modern deep-sea fauna", in which, in addition to the ancient species "very young settlers from low depths are also found" (p. 111). This position of the authors is illustrated by a number of examples, and as a result of the approximate evaluation of the role in deep-sea fauna of young and ancient elements leads to the conclusion that the latter are about 16% in it. At the same time, the authors write in the concluding section of the cited article: "The archaic-saturated abyssal fauna should be considered more ancient, and not younger than the shelf fauna" (p. 122). L. A. Zenkevitch [1969a, et al.] has repeatedly advanced the premise that the formation of large taxonomic groups of animals (taxons of the class and type rank) occurred only at shallow depths, from which the great depths were settled from deep antiquity. It is therefore not doubted that the cited article means not the absolute greatest antiquity of the abyssal fauna as a complex of species, but only the relatively great role in it as compared to the shelf fauna of the representatives of the ancient groups.

A. Bruun, in advancing the hypothesis of the catastrophic death of the deep-sea fauna, however, stipulates that if endemic deep-sea taxons are found above the subspecies [Bruun, 1957] or species rank [Bruun, Wolff, 1961], they should be viewed as preglacial relicts.

In the overwhelming majority of cases, the discrepancies in the viewpoints on the origin of deep-sea fauna thus concern the relative role in it of young and more or less ancient elements. The actual presence in it of different-age components in a certain form is adopted by almost all authors who discuss this topic. Therefore, the question of the antiquity or youthfulness of the deep-sea fauna on the whole is reduced to clarification of the relative role in it of endemic taxons of varying rank and age, and eurybathic species dwelling in the shallows that should be considered the youngest residents in the ocean depths. The currently available data on deep-sea fauna are still insufficient for reliable calculations of the numerical correlation in it of such different-age elements.

However, even now one can state that within the benthic fauna of great depths there are not only endemic species and genera known for them, but also taxons of the rank of family and even orders (e.g., suborders Cribellosa from the Asteroidea, Psychropotina from the Holothurioidea, Ascidia of the orders Octacnemida and Hexacrobilida, see: [Madsen, 1961b; Birstein, Vinogradov, 1971; Beliaev, 1974; Hansen, 1975]). As for the geological age of the taxons endemic for ocean depths, in cases where we have direct or indirect paleontological data about this, in the overwhelming majority they are dated no earlier than the Mesozoic era, most frequently the Cenozoic. Thus, for example, based on the data of A. N. Mironov [1986], the predecessors of the most ancient modern groups of abyssal Echinus for the first time penetrated from the sublittoral to the abyssal no earlier than the Jurassic, and most likely, in the Cenozoic. All the modern orders of Asteroidea emerged no earlier than the Mesozoic [Blake, 1987], and the only endemic deep-sea suborder Cribellosa and family Porcellanasteridae were probably formed in the late Mesozoic [Madsen, 1961b]. Fossil spicules of Holothurioidea, that hypothetically belong to the order Elasipoda, are known from the Devonian to the Jurassic [Frizzle, Exline, 1966; Pawson, 1966], but Holothurioidea not only of this order have similar spicules [Hansen, 1975]. Fossil spicules, that Hansen [1975] believes may be a prototype of spicules are characteristics for the abyssal suborder Psychropotina have been described from Triassic age deposits. Based on this, settlement of the abyssal depths by predecessor forms of modern Elasipoda should have occurred no earlier than the Mesozoic.

A. Clarke [1962b] based on the analysis of the taxonomic composition of modern fauna of deep-sea mollusks (except for Monoplacophora) and the geological age of its families and genera believes that none of the most ancient families emerged at great depths. Clarke believes that the modern fauna of deep-sea mollusks originates from groups whose settlement of the great depths should have occurred in the late Mesozoic or Cenozoic. In his monograph on Bivalvia, J. Knudsen [1970] notes that there are some families, and even 3 modern genera, whose representatives are known in the fossil state even from the Paleozoic. But all of these taxons are currently represented mainly at shallow depths, and there are no grounds to assume that the few abyssal representatives of these taxons populated the ocean depths in deep antiquity. Knudsen's conclusion is quite substantiated that the modern composition of abyssal Bivalvia fauna rather reflects modern ecological conditions, than the World Ocean geological history. It may be thought that this conclusion is also correct for other groups of abyssal fauna. As for the Monoplacophora, whose modern representatives were initially viewed as "live fossils", relicts preserved from the Paleozoic time, based on recent data, all currently existing representatives of this class belong to a special order that includes 4 modern families whose representatives are already known from three oceans in a broad range of depths from the upper bathyal to 6.5 km [Moskalev et al., 1983]. There are thus no grounds to consider the modern Monoplacophora as a relict group and there are no data to judge when the representatives of this class settled the abyssal depths.

Yet another group, Pogonophora, is currently widespread in all oceans and at all depths. In particular, diverse fauna of the class Vestimentifera is very characteristic for regions of outflows of deep-sea thermal springs (at depths 1.5-3 km) where they are represented by endemic taxons and form extremely massive settlements. There are known fossil tubules belonging to Pogonophora from shallow deposits of the Cambrian and late Precambrian [Poulsen, 1963; Sokolov, 1965, 1967, 1968]. B. S. Sokolov classifies these tubules as a special order Sabelliditida and believes that settlement of the depths by Pogonophora could have occurred even in the Paleozoic as a result of their displacement from the shoals by predators, trilobites. However this hypothesis is purely speculative, insofar as there is no complete confidence based only on the external similarity of the tubules about the relationship of Sabelliditida and modern Pogonophora. One can only state that many genera, and at least two families of modern Pogonophora (Lamellisabellidae and Spirobrachiidae) have only been found at great depths, where they were apparently formed. We do not have reliable data on the time for penetration of Pogonophora to the abyssal depths.

Among the modern deep-sea Brachiopoda, only the genus Pelagodiscus, which includes the widespread bathyal-abyssal species P. atlanticus, belongs to the family Discinidae, which also includes several fossil genera that are known from Paleozoic deposits [Zezina, 1985]. However, O. N. Zezina notes that the classification of both the modern and fossil Discinidae needs to be revised and that there are no grounds to hypothesize the time for appearance of deep-sea Discinidae.

Based on an analysis of the phylogenetic relationships within the order Isopoda, as well as the modern geographical and vertical dissemination of various groups of this order, O. G. Kussakin [1971b; Kussakin, 1973] concludes that the formation of Isopoda deep-sea fauna occurred, starting from the Miocene, and that its source was the cold-water fauna of the Antarctic shelf. J. L. Barnard [1961] notes that in this order there are no abyssal-endemic families and relatively few endemic genera, while the majority of abyssal species are closely related to shallow-water. All of this supports the geological youthfulness of the abyssal Amphipoda fauna.

The majority of the available data thus indicate that the modern deep-sea fauna (genera, species) originates from groups (at the taxon rank of families and orders) that were formed no earlier than the Mesozoic, and in many cases, in the Cenozoic.

The concept of the possible settlement of the ocean depths back in the Paleozoic agrees completely with the data that the ocean that existed by the beginning of the Paleozoic could not differ significantly from the the modern in its volume [A. P. Vinogradov, 1967; 1968; Yanshin, 1973], and consequently, in the presence in it of great depths. However, in light of the modern data on the excessive complexity of the ocean bottom relief and dynamic nature, the favorable trophic conditions in the eutrophic deep-sea regions of the modern ocean [Sokolova, 1986], that apparently in a certain form are characteristic for the ocean during its entire existence, as well as on the broad dissemination in the ocean of exceptionally abundant, and apparently, rapidly evolving deep-sea hydrothermal communities existing because of the local primary production of chemo-synthesizing bacteria, the previously stated concept could hardly be applicable now [Zenkevitch, Birstein, 1961; Carter, 1961] about the ocean depths as a refuge in which relict forms have been preserved from deep antiquity, and about the extremely slow rate of evolution of the deep-sea fauna.

Insofar as for the overwhelming majority of cases for representatives of the modern deep-sea fauna there is no paleontological chronicle to trace and date the evolution dates of this fauna, it seems correct to judge the degree of antiquity of the deep-sea fauna from the rank of taxons endemic for certain depths. This approach was suggested back in 1953 by A. P. Andriashev based on an analysis of deep-sea fish. Andriashev bases his division into ancient- and secondary deep-sea animals on the rank of taxonomic isolation of certain groups from the shallow fauna. He classifies with the first the forms that belong to families or orders that are endemic for considerable depths and with the second, forms that belong predominantly to shallow groups of which only individual representatives have adapted to life at the depths. It should be pinpointed that the ancient deep-sea (or as they are often called, primary deep-sea) groups may include individual shallow representatives who settled secondarily the shallow depths in the areas of upwelling of cold water or in the polar regions.

In relation to the affiliation to types and classes, almost all the ocean fauna, both shallow and deep-sea, is undoubtedly characterized by deep antiquity, insofar as the majority of taxons of this rank represented in the marine fauna is already known from the lower Paleozoic or from the Precambrian (see, e.g., :[Zenkevitch, 1971]). In the ocean depths, some groups apparently exist from the Paleozoic, while the formation of a number of orders and families occurred, starting from the Mesozoic. However, insofar as the fauna endemism of individual regions and vertical zones is reflected in the species, and partially on the genera level (on the family level as an exception) the fauna of each region should have been formed comparatively recently, although many of its representatives may be classified as ancient deep-sea groups. Specific species and genera endemic for the local fauna should have been formed mainly in the Cenozoic, partially starting from the Mesozoic. The degree of uniqueness of a certain locus (geographical or vertical) should be determined, on the one hand, by the duration of its existence in a geologically unaltered form, and on the other hand, by its features that affect the rate of fauna evolution. All of this refers to the trench ultra-abyssal fauna.[1]

The abyssal fauna should be the main source for settlement of the trenches [Zenkevitch, Birstein, 1955; Wolff, 1959a, b; Beliaev, 1966b, 1972, 1974], mainly the fauna of the neighboring regions to each trench or group of adjoining trenches of the ocean floor. Representatives of the ancient deep-sea groups (in the understanding of A. P. Andriashev) that were formed and evolved in the abyssal should have played the greatest role here. As a result of the lengthy existence at great depths under pressure of several hundred atmospheres, the animals belonging to these groups were as though pre-adapted to settlement of even greater depths. This is confirmed by the actual data regarding the composition and relationship of the trench fauna. One of the clearest examples that illustrate this premise is the Holothurioidea of the family Elpidiidae, and in particular, the genus, Elpidia [Beliaev, 1974a, 1975].

According to the theory of plate tectonics, the marginal deep-sea trenches that developed by subduction at the junctions of the lithospheric plates are not static formations, but are in constant change. The nature of floor movement of the marginal trenches may be popularly compared to the downward motion of a subway elevator. There is a constant process of submersion of the trench deepest sea floor under the continental plate and its replacement by the previously shallower sections of the ocean plate. With ever greater submersion of the ocean abyssal floor in the trench region, the animals populating this bottom naturally are submerged with it. However, this process occurs extremely slowly during a geologically prolonged time. Conversion of the former ocean floor into a deep-sea trench bottom occurs over hundreds of thousands or even millions of years. The duration of this process is comparable to the duration of species formation, and sometimes even evoluationary changes to higher taxonomic levels (genera, rarely families). The animals that even during the evolutionary process are incapable of adapting to extremely high pressure, during submersion into the ocean abyssal floor trench are screened, and are preserved only at depths normal for them. Others that belong to groups which are capable of adapting during evolution to ultra-abyssal depths (e.g., representatives of many genera of Isopoda Holothurioidea of Elpidia and other groups characteristic for the trench fauna), as the bottom submerges undergo adaptive changes, and in the final analysis, evolve to the level of endemic species, or even to taxons of genus and family ranks. The actual dynamics of change in the trenches during a lengthy geological time thus promote a "passive" penetration into the trenches of some animals from a number of dwellers on the ocean floor. Additionally, there is no doubt, that the trenches are settled by active penetration in them of abyssal animals and their adaptation to new conditions, and sometimes in considerably short periods. In particular, only this active settlement of the ultra-abyssal depths apparently occurred and is occurring in the fault trenches.

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[1] In one of his last publications, L. A. Zenkevitch [1970] also concluded that the modern trench benthic fauna has a Cenozoic age.

Our modern trench fauna studies are, as it were, instant photographs that reflect the most diverse stages in the evolutionary process of the formation of the ultra-abyssal fauna. In some cases, we can trace in different representatives of one family various stages of adaptation of animals to dwelling in the trenches, as in the example of a number of species and genera of Asteroidea of Porcellanasteridae [Beliaev, 1985a]. Sometimes the direct genesis can be traced of a certain ultra-abyssal species, e.g., for Asteroidea Caymenostellidae from the Caymen trench (see Chapter 4).

The settlement of the trenches and the formation in each of them of their own endemic taxons is fostered by the geographical isolation of various trenches, as well as the ecological isolation of the trenches by the pressure factor from the abyssal regions, and within the actual trenches, and at their various depths, by the diverse relief of the trench floor that determines the diversity of the biotypes and ecological niches, and the more favorable trophic conditions compared to the neighboring ocean floor regions. The role of spatial isolation for species formation is generally known. Other forms of isolation may be just as important, including environmental (see, e.g.,: [Shmal'gauzen, 1940, 1969]. As correctly noted by W. Thorpe [1945], both of these types of isolation may be viewed as spatial isolation of a varying scale. E. Mayr [1968] among the factors that promote rapid species formation, in addition to isolation, notes the diversity of free ecological niches, while I. I. Shmal'gauzen [1946], also notes the favorable feeding conditions. The rates of evolution in the trenches are evidently comparable to those in large freshwater lakes of tectonic origin (Baykal and East African Lakes), in which the fauna, sometimes with a great degree of endemism, was formed during a time from the middle of the Tertiary.

Elements of Antarctic origin are traced in many cases in the fauna of the trenches, including the most remote from the Antarctic. The Antarctic is apparently linked precisely with the origin of the ultra-abyssal Actinia Galatheantemidea, many Isopoda, some deep-sea Echinus, Holothurioidea Elpidea, Actinia of the genus Eremicaster, fish dwelling in the Kermadec trench of the genus Notoliparis and representatives of a number of other groups [Kussakin, 1971b; Kussakin, 1973; Menzies et al., 1973; Andriashev et al., 1973; Andriashev, 1975, 1978; Beliaev, 1975; 1985b; Beliaev, Vilenkin, 1983; Gebruk, 1983a, b; Mironov, 1986; et al.].

It should be stated in conclusion that adaptation to trench conditions that are extremely specific for extremely high pressure may apparently be viewed as a unique example of an evolutionary process called telemorphosis by I. I. Shmal'gauzen [1940]. In relation to comparatively few animals capable of adapting to extremely high pressure, the conditions existing in the trenches are favorable for evolution that results in the formation in them of endemic species, and in some cases, even genera. Cases of evolution to taxons of the family level in the trenches are already rare. Highly specialized fauna of the trenches apparently does not have a broader evolutionary outlook. No matter how long the trenches have existed, one can hardly expect that their fauna would be capable of evolving to higher taxons. The narrow one-sided specialization, even reflected only on the biochemical and physiological levels, should be an evolutionary impasse.

The 1988 publication of R. M. Kristensen and Y. Shirayama "Pliciloricus hadalis (Pliciloricidae), a New Loriciferan Species Collected from the Izu-Ogasawara Trench, Western Pacific", Zool. Sci., 1988, Vol. 5, No. 4, pp. 875-881 described a new species of the class Loricifera (type Cephalorhyncha) that was previously not known from depths over 6,000 m. This new species, Pliciloricus hadalis, was found in a sample obtained by a bottom grab during the expedition of the Japanese research vessel Hakuho-Maru (ORIUT, KH-80-1) in the Izu-Bonin trench at depth 8,260 m on March 3, 1980 (station 9.28°28.3' n.l., 143°19.6' e.l.).

APPENDICES

The appendices use the following abbreviations.
in the latitude/longitude columns:
e--east
w--west
n--north
s--south

Troughs, m (with geographical name) sea
Troughs:
A--Argentina
ZelM--Zeleniy Mys
CN--Canaries
EM--East Mariana
C--Central
Oceans:
Ao--Atlantic
In--Indian
NA--North Arctic
To--Pacific
ANT--Antarctic
Ark--Arctic
Trenches:
AL--Aleutian
B--Banda
BG--Bougainville
V--Vityaz
Volc--Volcano
IZ--Bonin
Imp--Imperator
Ca(B)--Cayman-Bartlet
Ca(O)--Cayman-Oriente
Kep--Kermadec
KK--Kuril-Kamchatka
M--Mariana
NB--New Britain
NH--New Hebrides
PL--Palau
P--Peru
PR--Puerto Rico
R--Romanche
CK--Santa Cruz
Ton--Tonga
PLP--Phillipine
K--Hjort
Ch--Chile
SS--South Sandwich
Y--Yavan

Jap--Japan

Appendix II uses the following abbreviations of the research vessels:

AK--Akademik Kurchatov, USSR
B--Vityaz, USSR
DM--Dmitriy Mendeleyev, USSR
AB--Anton Bruun, United States
Alb--Albatross, United States
Alb-2--Albatross, United States, Sweden
Arch--bathyscaphe Archimede, France
Cal--Calypso, France
Chal--Challenger, England
Elt--Eltanin, United States
Gal--Galathea, Denmark
Gil--Gillis, United States
HM--Hakuho-Maru, Japan
JEP--John Elliott Pilsbury, United States
PrA1--Princesse Alice, Monaco
RM--Riofu-Maru, Japan
SM--Soyo-Maru, Japan
SpFB--Spencer F. Baird, United States
TW--Thomas Washington, United States
Tr--bathyscaphe Trieste, Switzerland, United States

APPENDIX I

LIST OF THE STATIONS AT WHICH DIFFERENT EXPEDITIONS MADE CATCHES, TOOK PHOTOGRAPHS OR MADE OBSERVATIONS OF ANIMALS AT DEPTHS OVER 6,000 m

The information on foreign expeditions was based on published data. When the information regarding the location of a certain station, depth of sample-taking, composition and population of the caught animals does not coincide in various sources, the latest data were used. If the data processing has not yet been done or has not been completed, information based on preliminary publications was utilized.

The location and depths of the Soviet expedition stations are given based on original data. The number of species and specimens in the catch for the most part are indicated based on preliminary, approximate calculations; these data do not include information about Foraminifera or Xenophyophoria since there is no information about what percentage of the catch were live specimens, or only skeletal remains.

The coordinates and depths of the Galathea research vessel are given by the refined list cited in the work of A. Bruun [1958].

The letter designations to the right of the station number indicate the type of work: T--collection by various trawl lines or drag nets, D--bottom grab samples, P--underwater photography, C--collections by closing plankton nets. The benthos biomass data are given for bottom grab samples.

More detailed information about the composition of the trawling catches obtained by the Soviet expeditions is given in the following publications: Beliaev, 1966b, 1972; Vinogradova, 1974; Vinogradova et al., 1974, 1978; Beliaev, Mironov, 1977a; data on the plankton catches are found in: Vinogradov, M. Ye., 1960a, 1968, 1970.

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TABLE 1.

Key for Table 1

a. Date
b. No. of station
c. Region
d. Coordinates
e. Latitude
f. Longitude
g. Depth, m
h. Number of species (specimens) in catch
i. Biomass, g/m^2
j. England
k. United States
l. Monaco
m. Sweden
n. Vityaz
o. All of the Soviet expeditions used the Okean bottom grab 0.25 m^2. Sometimes the animals were selected from part of the sample equal to 0.2 m^2
p. 14 species of Foraminifera
q. Fragment of sponge

Column 3:
1. northwest trough
2. northeast trough

*Depths for the beginning and ending of trawling.
** Without consideration for the large Echiuroidea weighing 10 g.

TABLE 1

Таблица 1

Дата a	№ станции b	Район c	Координаты d Широта e	 Долгота f	Глубина, м g	Число видов (экземпляров) в улове h	Биомасса, г/м² i
1	2	3	4	5	6	7	8
"Челленджер" ("Challenger"), Великобритания, 1875 [Brady, 1884] j							
18.VI 1875	238	Япон JAP проба лотовой трубкой SAMPLE OF SOUNDING TUBE	35° 18′с n	144°08′в e	7220	14 видов форaминифер p	
"Альбатрос" ("Albatross"), США, 1899 [Agassiz, 1902] k							
27.XI 1899	3693 Т	Тон TON	21° 18′ ю s	173°31′з w	7632	Фрагмент стеклянной губки	
"Принцесса Алиса" ("Princesse Alice"), Монако, 1901 [Koehler, 1909; Sluiter, 1912; Roule, 1913] l							
6.VIII 1901	1173 Т	TROUGH Котл ЗелМ ZelM	12°08′с n	33°34′ з w	6035	5 (7)	
"Альбатрос-2" ("Albatross"), Швеция, 1948 [Eliason, 1951; Nordenstam, 1955; Madsen, 1955] m							
17.VIII 1948	370 Т	ПР PR	19°45′с n	64°52′ з w	7625–7900*	4 (24)	
"Витязь", СССР, 1949–1976 n							
o Во всех экспедициях СССР использовался дночерпатель "Океан" 0,25 м². Иногда животные выбирались из части пробы, равной 0,2 м²							
10.X 1949	162 Т	КК	44°56′ с	152°24′ в	8100	20 (160)	
26.V 1953	2120 Т	КК	46°14′ с	154°11′в	8330–8430	21 (160)	
1.VI 1953	2144 Т	КК	48°25′ с n	156°24′в e	6860	44 (400)	
22.VI 1953	2208 Т	КК	49°29′ с	158°41′в	7210–7230	51 (780)	
26.VI 1953	2216 Т	КК	45°41′ с	153°24′ в	8610–8660	9 (290)	
29.VI 1953	2217 Т	КК	44°08′ с	150°32′в	9000–9050	21 (5500)	
1.VII 1953	2218 Т	КК	43°48′ с	149°55′ в	ok. 9500	5 (244)	
	П P				8500–6000		
4.X 1954	3168 Д D	КК	45°42′ с	152°37′в	6150	11 (30)	1,65
6.X 1954	3176 Т	КК	44°08′ с	150°22′в	8175–8840	17 (2500)	
25.X 1954	3214 Т	J Япон	38°11′ с n	143°56′в e	6156–6207	57 (600)	
3.V 1955	3227 Т	P Япон	38°02′ с	143°57′в	7190	9 (22)	
6.V 1955	3232 Т	I С-з котл То	33°18′ с	149°46′в	6096	50 (180)	
6.V 1955	3232 ДD	I С-з котл То	33°18′ с	149°46′в	6126	9 (10)	2,16
17.V 1955	3257 Д D	КК	48°48′ с	157°00′в	6938	8 (40)	3,44
1.VI 1955	3340 Т	Ал AL	53°53′ с	166°56′в	6410–6757	13 (75)	
2.VI 1955	3340 Д D	Ал	53°53′ с n	166°56′в e	6460	6 (7)	0,4
7.VI 1955	3357 Т	Ал	52°26′с	170°54′в	7246	24 (100)	
7.VI 1955	3357 Д D	Ал	52°26′с	170°54′ в	7286	11 (25)	0,56**
11.VI 1955	3363 Т	2 С-в котл То	48°15′ с	169°39′в	6272–6282	45 (1350)	
18.IX 1955	3456 ДD	I С-з котл То	34°51′с	149°46′в	6056	10 (13)	0,22

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* Глубины начала и конца траления.

**Без учета крупной Echiuroidea весом 10 г.

TABLE 1 (CONTINUATION)

* Without consideration for the sea urchin (Purtalesiidae) weighing several grams.

Таблица (продолжение)

1	2	3	4	5	6	7	8
21.IX 1955	3457 Т	КК	41°17′ с	145°50′в	6475–6571	38 (370)	
25.IX 1955	3471 ДD	С-з котл То	33°11′ с	153°08′в	6076	13 (22)	0,15*
7.X 1955	3491 Т	ИБ I	30°34′ с	142°41′в	7305–7315	9 (100)	
8.X 1955	3494 Т	ИБ B	29°09′ с	142°53′ в	9715–9735	12 (90)	
14.X 1955	3503 Т	Волк Volc	23°03′ с	144°59′в	7584–7614	5 (7)	
21.X 1955	3514 Т	ИБ IB	27°59′ с	143°16′в	8530–8540	4 (4)	
27.X 1955	3528 Т	Рюкю RYUK	27°58′с	130°28′в	6810	10 (240)	
30.IV 1957	3571 Т	Япон J	38°57′с	143°57′в	7565–7587	35 (1640)	
23.V 1957	3593 Т	Япон AP	40°55′с	144°53′в	6380	26 (137)	
12.VII 1957	3634 Т	В-Мар котл То E M	12°45′с	153°52′в	6040	1 (1)	
20.VII 1957	3655 Т	Буг B	5°49′ю	152°53′в	6920–7657	35 (240)	
27.VII 1957	3663 Т	Буг G	6°13′ ю	153°44′в	7974–8006	36 (220)	
28.VII 1957	3663а Т	Буг	6°22′ ю	153°44,5′в	8980–9043	10 (120)	
15.VIII 1957	3663 П P	Буг C	6°17′ю	153°45′в	8200–6700		
26.XI 1957	3793 ДD	Центр котл То	8°34′с	174°14′з	6013	3 (3)	0,48
23.XII 1957	3818 Т	Тон	20°06′ю	173°16′з	7354–8411	6 (7)	
26.XII 1957	3823 Т	Тон	23°04′ю	174°46′з	9735–9875	1 (2)	
28.XII 1957	3823 А Т	Тон	23°13′ю	174°38′з	10415–10687	14 (47)	
2.I 1958	3827 Т	Кер	28°53′ю	176°01′ з	8928–9174	20 (320)	
4.I 1958	3829 П P	Кер	30°32′ю	177°39′з	7960–6170		
6.I 1958	3831 Т	Кер	31°50′ю	177°14′з	9995–10015	10 (150)	
30.I 1958	3849 Т	НГ NH	20°32′ю	168°30′в	6680–6830	17 (70)	
3.II 1958	3855 ДD	Вит V	10°27′ ю	170°17′в	6135	2 (4)	0,02
23.V 1958	4004 Т	Мар M	11°18′с	142°21′в	10630–10710	5 (11)	
24.V 1958	4005 Т	Мар	11°29′с	142°14′в	7990–8130	2 (3)	
20.X 1958	4074 Т	2 С-в котл То	40°20′с	175°45′з	6065	70 (425)	
20.X 1958	4074 ДD	С-в котл То 2	40°20′с	175°45′з	6065	8 (10)	0,105
5.XI 1958	4120 Т	Ал AL	53°38′с	159°41′з	6296–6328	25 (600)	
25.II 1959	4355 Т	1 С-з котл То	24°02′с	167°24′в	6051	16 (30)	
25.II 1959	4355 ДD	1 С-з котл То	24°02′с	167°24′в	6051	3 (5)	0,02
2.III 1959	4370 Т	1 С-з котл То	26°04′с	153°49′в	6107–6127	9 (23)	
3.III 1959	4370 ДD	1 С-з котл То	26°04′с	153°49′в	6080	6 (7)	0,25
1.XI 1959	4530 Т	Яв	10°17′ю	110°20′в	6935–7060	8 (515)	
4.XI 1959	4535 Т	Яв Y	9°58′ ю	107°56′в	6820–6850	28 (715)	
5.XI 1959	4535 ДD	Яв	10°08′ю	107°55′в	6841	6 (11)	0,56
10.XI 1959	4541 Т	Яв	8°58′ю	105°27′ в	6477–6487	3 (80)	
10.XI 1959	4541 ДD	Яв	8°58′ю	105°27′в	6487	6 (10)	0,09
17.VII 1962	5168 Т	Яв	8°42′ю	105°31′в	6433–6475	27 (390)	
18.VII 1966	5607 Т	КК	46°12′с	153°17′в	6080–6185	2 (2)	
18.VII 1966	5607 ДD	КК	46°12′с	153°13′в	6225	15 (45)	2,4
22.VII 1966	5608 Т	КК	46°00′с	153°27′в	7265–7295	41 (270)	
22.VII 1966	5608 ДD	КК	46°05′с	153°32′в	6835	10 (30)	2,36
23.VII 1966	5609 Т	КК	46°06′с	153°18′в	6090–6235	39 (200)	
25.VII 1966	5611 Т	КК	45°48′с	153°21′в	7600–7710	16 (290)	

~~*Без учета морского ежа (Pourtalesiidae) весом несколько граммов.~~

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TABLE (continuation)

*The dash means that the sample is not representative.

**Without consideration for starfish with weight about 1 g.

~~Таблица (продолжение)~~

1	2	3	4	5	6	7	8
27.VII 1966	5612 Т	КК	45°25′с	153°07′в	8185–8400	35 (5200)	
	ПP				8000–7000		
			h		e 7000–6000		
2.VIII 1966	5613 Т	КК	45°25′с	152°45′в	9030–9530	8 (4500)	
3.VIII 1966	5615 Т	КК	45°56′с	153°28′в	8060–8135	24 (200)	
4.VIII 1966	5616 Т	КК	45°40′с	153°33′в	7795–8015	40 (350)	
6.VIII 1966	5617 Т	КК	45°32′с	153°46′в	6675–6710	60 (500)	
	ПP				7000–6000		
21.VIII 1966	5625 Т	КК	45°28′с	153°46′в	6205–6215	35 (300)	
25.VIII 1966	5626 ПP	КК	45°11′с	152°29′в	8700–6800		
					7000–6000		
28.VIII 1966	5627 Т	КК	44°15′с	150°46′в	9170–9335	12 (3800)	
30.VIII 1966	5628 Т	КК.	43°54′с	149°57′в	9520–9530	12 (20000)	
29.VIII 1966	ПP				8000–6500		
31.VIII 1966	5629 ДD	КК	43°55′с	149°47′в	8355	15 (70)	3,30
31.VIII 1966	5629 Т	КК	43°54′с	149°43′в	8035–8120	21 (140)	
1.IX 1966	5630 Т	КК	43°39′с	149°39′в	6435–6710	20 (45)	
4.IX 1966	5631 Т	КК	43°47′с	149°43′в	9070–9345	15 (8400)	
5.IX 1966	5632 Т	КК	43°44′с	149°52′в	8240–8345	20 (280)	
5.IX 1966	5633 Т	КК	44°07′с	149′34′в	6090–6135	71 (1100)	
23.IV 1968	6012 ДD	С-з котл То	25°38′с	167°54′в	6160	4 (3)	0,17
24.IV 1968	6014 ДD	С-з котл То	26°39′с	166°10′в	6160	3 (3)	0,05
1.V 1969	6085 Т	Ал	50°49′с	173°29′з	6965–7000	25 (1200)	
11.VI 1969	6139 Т	Ал A	53°08′с	163°06′з	6520–6550	9 (65)	
11.VI 1969	6139 ДD	Ал L	53°07,5′с	163°07′з	W 6520	13 (300)	4,64
13.VI 1969	6140 Т	Ал	52°55′с	163°20′з	6960	8 (23)	
13.VI 1969	6140 ДD	Ал	52°57′с	163°15′з	6980	10 (100)	0,30
16.VI 1969	6144 Т	Ал	51°42,5′с	168°05′з	7200	13 (110)	
20.VI 1969	6145 Т	Ал	51°10′с	174°35,5′з	7250	30 (130)	
28.VI 1969	6151 Т	Япон J	37°41,5′с	143°54′в	7370	33 (3600)	
29.VI 1969	6152 Т	Япон A P	37°00′с	143°23′в	e 6600–6670	23 (200)	
2.VII 1969	6153А Т	ИБ IB	34°32,5′с	142°06′в	8800–8830	15 (260)	
30.V 1970	6275-2 Т	Центр C котл То	12°12′с	179°49′в	6400	12 (40)	
18.VI 1970	6291 ДD	Тон T	19°22′ю	173°07′з	W 6850	2 (2)	–*
18.VI 1970	6293 ДD	Тон O	19°37′ю	S 172°43′з	6600	2 (2)	0,02
21.VII 1970	6327 Т	Тон N	23°16′ю	174°52′з	8950–9020	18 (100)	
15.II 1973	6710 ДD	Фил P	6°45,7′с W	127°35′в	6100	5 (5)	0,07**
12.IV 1973	6782 ДD	Бан B	5°31′ю S	131°40′в	e 5980	11 (32)	1,18
13.IV 1973	6784 ДD	Бан	5°31,5ю	131°22′в	6250	6 (54)	0,68
13.IV 1973	6785 Т	Бан	5°38,4′ю	131°08′в	7130	15 (80)	
13.IV 1973	6785ДD	Бан	5°38,4′ю	131°08′в	7130	6 (40)	0,56
21.IV 1973	6809Т	Фил P	4°40′с h	128°03′в	8080–8400	15 (285)	
6.II 1975	7164ДD	Рюкю R	25°16,4′с	128°36,7′в	7310	2 (2)	–
6.II 1975	7165ДD	Рюкю Y	25°17′с	128°33′в	7390	5 (5)	0,08
6.II 1975	7166ДD	Рюкю U	25°16,4′с	128°32′в	7380	3 (3)	–
7.II 1975	7167Т	Рюкю K	25°13′с	128°31′в	6660–6670	10 (30)	
7.II 1975	7168Т	Рюкю	25°11,5′с	128°27,4′в	7440–7450	14 (166)	
15.II 1975	7202Т	Фил P	10°19′с	126°41,7′в	9750	8 (26)	

*Прочерк — проба не репрезентативная.

**Без учета морской звезды весом около 1 г.

TABLE (continuation)

Таблица (продолжение)

1	2	3	4	5	6	7	8
16.II 1975	7205ДD	Фил	10° 25′ с	126° 53,6′в	e 6460	2 (3)	0,05
16.II 1975	7206Т	Фил	10° 24′с n	126° 49,7′в	7420–7880	23 (71)	
17.II 1975	7206ДD	Фил	10° 24′с	126° 52′в	7850	0 (камни) Rocks	
17.II 1975	7206ДD	Фил P	10° 22′ с	126° 49′в	7900	3 (3)	0,012
17.II 1975	7207Т	Фил	10° 21,6′с	126° 39′в	9980–9990	25 (320)	
17.II 1975	7208ДD	Фил	10° 21′с	126° 35,7′в	9340	8 (75)	0,10
19.II 1975	7211Т	Фил	10° 23,7′с	126° 42′в	8440–8580	14 (137)	
19.II 1975	7212Т	Фил	10° 20,6′с	126° 29′в	7000	6 (10)	
19.II 1975	7212ДD	Фил	10° 21, 6′с	126° 25,5′в	6630	2 (5)	0,012
19.II 1975	7213Т	Фил	10° 23′ с	126° 23, 4′ в	6290–6330	22 (160)	
20.II 1975	7214Т	Фил	10° 23,6′с	126° 35,2′в	9360–9390	7 (28)	
21.II 1975	7216Т	Фил	10° 20,6′с	126° 32′в	7610–7740	8 (8)	
22.III 1975	7271Т	Бан B	5° 37′ю s	131° 07,5′в	7335–7340	14 (300)	
27.III 1975	7289Т	Пал PL	7° 43,5′с n	134° 56,6′в	7970–8035	17 (195)	
28.III 1975	7291Т	Пал	7° 50′с	130° 03′в	7000–7170	34 (435)	
30.III 1975	7298Т	Яп Y	8° 23,4′с	137° 52′в	8560–8720	16 (170)	
30.III 1975	7299Т	Яп A P	8° 26,2′с	137° 50,5′ в	7230–7280	12 (23)	
31.III 1975	7300Т	Яп	8° 28,6′с	137° 52,5′в	7190–7250	18 (54)	
21.IV 1975	7353Т	Мар	11° 22′с	142° 16,8′в	10220–10275	3 (5)	
22.IV 1975	7354Т	Мар	11° 15,4′с	142° 14′в	10170–10180	3 (11)	
23.IV 1975	7356ДD	Мар	11° 07′с	142° 20′в	6980	4 (2)	0,024
24.IV 1975	7359Т	Мар M	11° 21,2′с	142° 13,6′в	10700–10730	5 (19)	
24.IV 1975	7360Т	Мар	10° 58,2′с	142° 08,6′в	6580–6650	7 (15)	
25.IV 1975	7361Т	Мар	11° 03′с	141° 57′в	7340–7450	2 (8)	
26.IV 1975	7363ДD	Мар	11° 07,2′с	141° 39,5′в	9540	1 (1)	0,10
28.IV 1975	7370Т	Мар	11° 25,6′с	143° 05,5′в	8890–8900	3 (5)	
29.IV 1975	7371Т	Мар	11° 22,5′с	143° 27,6′в	8215–8225	10 (46)	
29.IV 1975	7371ДD	Мар	11° 23′с	143° 26′в	8380	1 (1)	0,07
4.V 1975	7389Т	Волк V	23° 52,5′с	143° 59,6′в	8530–8540	13 (31)	
5.V 1975	7389ДD	Волк O L	23° 55,3′с	144° 02,6′в	8780	1 (1)	0,01
5.V 1975	7390Т	Волк C	23° 56,3′с	144° 05′в	6780–6785	7 (8)	
6.V 1975	7391Т	Волк	24° 07′с	143° 47′в	6330	31 (370)	
9.V 1975	7404Т	ИБ I	29° 15′с	142° 30′в	6770–6890	30 (165)	
10.V 1975	7405Т	ИБ B	29° 30,2′с	142° 31,6′в	8550–8560	3 (7)	
10.V 1975	7406Т	ИБ	29° 17,6′с	142° 53,6′в	8900	8 (11)	
11.V 1975	7407Т	ИБ	29° 18′с	143° 15,4′в	6770–6850	35 (533)	
21.VI 1976	7499Т	Япон J	37° 58,5′с	144° 12′в	6480–6640	40 (500)	
22.VI 1976	7500Т	Япон A	37° 39′с	143° 58,3′в	7350–7370	30 (1550)	
23.VI 1976	7503Т	Япон P	36° 44,5′ с	143° 19′в	7540	32 (450)	
27.VI 1976	7511Т	Япон	38° 41′с	144° 08,5′в	7490	9 (15)	
27.VI 1976	7511ДD	Япон	38° 39′ с	144° 06,8′в	7500	14 (100)	4,84
28.VI 1976	7512Т	Япон	39° 07′ с	144° 03,4′ в	6330	3 (3)	

r

"Галатея" ("Galathea"), Дания, 1951–1952

S [Bruun, 1958; Wolff, 1960; статьи многих авторов
по различным систематическим группам животных в серии "Galathea Report"]
Экспедицией на "Галатее" использовался дночерпатель Петерсена 0,2 м²

21.VII 1951	418Т	Фил	10° 13′с	126° 43′в	10150–10190	5 (123)	
22.VII 1951	419Т	Фил	10° 19′с n	126° 39′в e	10150–10210	4 (24)	
27.VII 1951	424Д	Фил P	10° 28′с	126° 39′в	10120	1 (1)	0,5
2.VIII 1951	429Т	Фил	9° 49′ с	126° 44′ в	10020–10120	1 (3)	
7.VIII 1951	435Т	Фил	10° 20′с	126° 41′в	9820–10000	5 (8)	
3.IX 1951	462Д	Яв Y	10° 02′ю s	107° 52′в	6730	3 (3)	
5.IX 1951	465Т	Яв	10° 20′ю	109° 55′в	6900–7000	7 (28)	

Key:

r. Denmark
s. articles of many authors on different taxonomic groups of animals in the series "Galathea Report"]
The expedition on Galathea used the bottom grab Petersen 0.2 m^2

TABLE (Continuation)

Key:

Columns 7/8:

1. 2 photographs were obtained of the bottom with animals
2. 2 species, data about the rest of the catch are unknown
3. Data about the rest of the catch have not been published
4. Observations of animals through bathyscaphe portholes
5. Bottom photographs with animalsl
6. The same
7. Data about the catch are unknown
8. Bottom photographs

Column 2:

m': biotrawl
n': bottom grab

t. France
u. Bathyscaphe Trieste, Switzerland, United States
v. [cited in Piccard; Dietz, 1963]
y. In the region of stations 35 and 37 at depth somewhat over 6,000 m 23 photographs of the bottom were also obtained.

*The depth indicated for this station is exaggerated; according to the later datat, the greatest depth of this trench is 7,856 m.

Таблица (продолжение)

1		2	3	4	5	6	7	8
6.IX	1951	466Т	Яв. Y	10°21′ю	110°12′в	7160	7 (3170)	
22.IX	1951	494Т	Бан B	5°36′ю	131°01′ в	e 7240–7290	3 (4)	
22.IX	1951	495Т	Бан	5°26′ ю	S 130°58′ в	7250–7290	15 (105)	
23.IX	1951	496Д	Бан	5°36′ю	131°06′ в	7270	3 (5)	12,5
23.IX	1951	497Т	Бан	5°18′ю	131°18′в	6490–6650	10 (70)	
24.IX	1951	499Д	Бан	5°21′ ю	131°17′в	6580	8 (12)	11,0
13.X	1951	517Т	Бут BG	6°31′ю	153°58′в	8940	4 (19)	
16.X	1951	521Т	Бут	5°59′ю	153°28′ в	8780–8830	2 (76)	
14.II	1952	649Т	Кер	35°16′ю	178°40′ з	8210–8300	19 (2100)	
15.II	1952	650Т	Кер	32°20′ю	176°54′ з	W 6620–6730	25 (425)	
16.II	1952	651Т	Кер	32°10′ю	177°14′з	6960–7000	29 (210)	
17.II	1952	653Т	Кер	32°09′ю	176°35′з	6180	10 (63)	
20.II	1952	656Т	Кер	35°20′ю	178°55′з	7640–7680	1 (1)	
20.II	1952	658Т	Кер	35°51′ ю	178°31′з t	6660–6770	32 (1100)	
			”Калипсо” (”Calypso”), Франция, 1956 [Edgerton et al., 1957; Cousteau, 1958]				1	
JULY Июль	1956	2–Ф	Ром R	0°10′ю S	18°21′з W	7948*	Получены 2 фотографии дна с животными	
			k ”Вима” (”Vema”), США, 1958–1959 [Menzies et al., 1959; Clarke, 1961; Menzies, 1962; Barnard, 1964]					
9.XII	1958	15–69Т (Био- m′ трал №154)	Пер P	10°13′ю S	80°05′з W	6324–6328	20 (1000)	
28.III	1959	15–126Т (Био- трал m′ №210)	A Аргент котл	47°57,5′ю S	48°03′ з W	6079	1 2 вида, данные об остальной части улова неизвестны	
12.IV	1959	15–151Т (Био- трал m′ № 235)	PR ПР	18°45′ с A	66°30′ з W	6264	3 Данные об улове не опубликованы	
			u Батискаф ”Триест” (”Trieste”), Швейцария и США, 1960 V [Piccard, 1960; Piccard, Dietz, 1961 (цит. по: Пиккар, Дитц, 1963]				4	
23.I	1960		Мар M	11°18,5′с n	142°15,5′в E	10910	Наблюдения животных через иллюминатор батискафа	
			w ”Риофу-Мару (”Riofu-Maru”), Япония, 1961 [Suyehiro et al., 1962]					
9.VI	1961	Е-2Т	JAP Япон	38°00′ с n	144°05′ в e	6700–7340	20(219)	
			k ”Чейн” (”Chain”), США, 1961–1962 [Pratt, 1962; Heezen et al., 1964; Todd, Low, 1964]				5	
	1961	E Ф-1	Ром R	0°14′ю S	18°33′ в e	6400–6670	Фотографии дна с животными	
	1961	E Ф-2 n′	Ром	0°16′ю S	18°35′з w	7130–7320	То же 6	
XII	1962	Драгировка	ПР PR	20°17′с n	65°42′з w	5850–6400	7 Данные об улове неизвестны	
	1962	Ф F	ПР PR	18°45′с n	66°26′з W	7865	8 Фотографии дна	

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*Глубина, указанная ~~для этой станции,~~ преувеличена – по более поздним ~~данным,~~ наибольшая ~~глубина этого желоба~~ 7856 м.

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Table (continuation)

Key:

Column 7/8:
9. At stations about 4,000 stereoscopic (color and black/white)
10. bottom photographs were obtained and the benthic layer at which diverse animals were visible
11. There is no information about the catch
12. 20 specimens of Polychaeta; there is no information about the rest of the catch
13. Bottom photographs with animals were obtained at these 3 stations
14. Animal observations through the porthole
15. Several fish were noted through the porthole; a silt sample was taken with fragment of Holothurioidea
16. Diverse animals were found; fish were observed

Column1:
z. Summer
a'. In the Pacific Ocean near Japan, 8 descents were made to depths from 5,485 to 9,750 m. Diverse benthic animals were found, and some of them were collected; for the first time at depth about 6,500 m Decapoda (shrimp) were discovered for the first time.

* Lemche et al. [1976] call the Santa Cruz trench the northern part of the New Hebrides trench.

Таблица (продолжение)

1	2	3	4	5	6	7	8
k x ”Спенсер Ф. Бэрд (”Spencer F. Baird”), США, 1962. Экспедиция PROA [Lemche et al., 1976]							
23.IV 1962	Ф-2	Пал PL	7°44′с n	134°55,5′в	8021–8042	9 На 7 станциях получено около 4000 стереоскопических (цветная + + черно-белая) 10 фотографий дна и придонного слоя, на которых видны разнообразные животные	
11.V 1962	Ф-5	НБ N	5°58,5′ю	152°15′в e	8258–8260		
16.V 1962	F Ф-6	НБ B	5°50,8′ю S	152°32,2′в	7875–7921		
16.V 1962	Ф-7	НБ	5°48′ю	152°28′в	7057–7075		
19.V 1962	Ф-8	Буг BG	6°16,7′ю	153°43,4′в	7847–7862		
29.V 1962	Ф-10	СК*	12°17′ю	165°48,7′в	8712–8930		
6.VI 1962	Ф-11	НГ NH	20°32,9′ю	168°33′в	6758–6776		
k ”Илтенин” (”Eltanin”), США, 1962–1963 [Menzies, 1963, 1964; Bandy, Rodolfo, 1964; Heezen, Johnson, 1965; Studies in Antarctic oceanology, 1965; Hartman, 1967b; Menzies et al., 1973]							
7.VI 1962	35Т	Пер P	8°22′ю S	81°04′з W	6250		
8.VI 1962	37Т	Пер P	8°10′ю	81°09′з	6006	20 (12700)	
y В районе ст. 35 и 37 на глубине несколько более 6000 м получены также 23 фотографии дна с животными							
26.IV 1963	586Т	ЮС S	54°53,5′ю	28°32′з	7329	11 Сведений об улове нет	
29.IV 1963	589Т	ЮС S	55°07′ю S	26°00′з W	7686	12 20 экз. полихет; об остальном улове 11 сведений нет 11	
24.V 1963	641Т	ЮС	57°19′ю	24°28′з	6661–6669	Сведений об улове нет	
IV–VI 1963	Е-8-7	ЮС	55°56′ю	25°04′з	7610	13 На этих 3 станциях получены фотографии дна с животными	
	Е-8-18	ЮС	59°36′ю	24°19′з	6710		
	Е-8-20	ЮС	57°58′ю	23°53′з	6880		
t Батискаф ”Архимед” (”Archimede”), Франция, 1962–1967 [Anonym, 1962, 1963, 1964, 1967; Cherbonnier, 1964; Wolff, 1964; Pérès, 1965; Laubier, 1985]							
25.VII 1962		КК			9545	14 Наблюдения животных через иллюминатор	
12.VIII 1962		ИБ IB	33°30′с n	141°56′в e	9180	15 Через иллюминатор замечены несколько рыб; взята проба ила с фрагментом голотурии	
V–VI 1964		ПР PR			7200; 8300	16 Обнаружены разнообразные животные; удалось наблюдать рыб	
2 Лето 1967	a′ В Тихом океане вблизи Японии проведено 8 погружений на глубины от 5485 до 9750 м. Обнаружены разнообразные донные животные, и некоторые из них собраны; впервые на глубине около 6500 м обнаружены десятиногие ракообразные (креветки)						

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*Лемхе с соавторами [1976] называют желоб Санта-Крус северной частью Ново-Гебридского желоба.

Page 160 Table Continuation

Key:
b'. On the 11th trip of the research vessel Anton Bruun, the samples of the benthic fauna were taken by the biological trawl (BT), the Menzies trawl for collection of microbenthos (TM) and Campbell bottom grab with area 0.6 m^2 (D). Data on the location of the stations and depths are preliminary; complete information about the animal catch has not been published.

c' . Akademik Kurchatov, USSR

Columns 7/8:
17. Bottom photographs have been obtained.

Таблица (продолжение)

1		2	3	4	5	6	7	8
"Антон Бруун" ("Anton Bruun"), США, 1965 K								
[Menzies, Chin, 1966; Frankenberg, Menzies, 1968; Kornicker, 1970; Timm, 1970; Băcescu, 1971; b' Menzies et al., 1973; Gardiner, 1975; Баческу, 1981]								
В 11-м рейсе э/с "Антон Бруун" сборы донной фауны проводились большим биологическим тралом (БТ), тралом Мензиса для сбора микробентоса (ТМ) и дночерпателем Кемпбелла площадью 0,6 м² (Д). Данные о местоположении станций и глубинах предварительные; полные сведения о пойманных животных не опубликованы								
12.X	1965	72BТ, ТМ	Пер	8°25'ю	81°05'з	6052–6220		
12.X	1965	73ДD	Пер P	8°21'ю	81°07'з	6229	>10 (28)	0,85
12.X	1965	75BТ, ТМ	Пер	8°20'ю	81°04'з	6220–6364		
13.X	1965	77BТ, ТМ	Пер	8°22'ю S	81°02'з	6260		
15.X	1965	98BТ, ТМ	Пер	8°24'ю	81°15'з	5989–6052		
16.X	1965	99ДD	Пер	8°20'ю	81°00'з W	6052		
16.X	1965	100BТ	Пер	8°16'ю	81°05'з	6156–6489		
19.X	1965	113 BТ, ТМ	Пер	8°44'ю	80°45'з	5986–6134		
5.XI	1965	189ФF	Пер	8°55'ю	80°51'з	6260	17 Получены фотографии дна	
6.XI	1965	190BТ	Пер	8°53'ю	80°49'з	6104–6314		
6.XI	1965	191ТМ	Пер	8°52'ю	80°47'з	6146–6313		
6.XI	1965	192ФF	Пер	8°56'ю	80°47'з	6156	17 Получены фотографии дна	
6.XI	1965	193ТМ	Пер	8°56'ю	80°47'з	6073–6281		
8.XI	1965	197BТ	Пер	11°30'ю	79°25'з	6146–6354		
C' "Академик Курчатов", СССР, 1967–1973								
16.I	1967	7Т	Ром	0°11'ю	18°21,5'з	7200	6 (80)	
17.I	1967	8ДD	Ром R	0°16'ю	18°20'з W	7280	9 (17)	0,54
18.I	1967	9Т	Ром	0°10,5'ю	18°20'з	7340	6 (12)	
11.IV	1967	30Т	Вима Ve	9°10'ю	67°14'в	6160–6300	3 (12)	
25.IX	1968	244Т-1	Чил C	23°29'ю	71°25'з	7000	25 (40)	
25.IX	1968	244Д-1D	Чил	23°24'ю S	71°22'з	7400	8 (20)	1,01
27.IX	1968	244Т-2	Чил h	23°25'ю	71°22'з	7720	10 (40)	
27.IX	1968	244Д-2D	Чил	23°26'ю	71°22'з	7720	7 (36)	1,08
1.XI	1968	294Т	Пер	8°23'ю	81°01'з	6200–6240	20 (150)	
1.XI	1968	294Д-1D	Пер P	8°20'ю	81°01,5'з	5960	11 (120)	2,34
1.XI	1968	294Д-2D	Пер	8°23'ю	81°01'з	6240	14 (75)	2,88
2.XI	1968	296Т	Пер	8°10'ю	81°04'з	6040	20 (200)	
2.XI	1968	296Д-1D	Пер	8°13'ю	81°04'з	6040	8 (90)	0,61
2.XI	1968	296Д-2D	Пер	8°10'ю	81°04'з	6100	8 (70)	18,70
27.XI	1971	864Т	ЮС	55°09'ю	27°00,3'з	7200–7216	56 (4900)	
27.XI	1971	864ДD	ЮС S	55°10'ю	26°50'з	7218	6 (20)	0,49+
28.XI	1971	866Т	ЮС S	55°06,6'ю	26°41,5'з	7694–7934	31 (7500)	
28.XI	1971	867Т	ЮС	55°14,4'ю	26°17,3'з	8004–8116	14 (640)	
5.XII	1971	895Т	ЮС	56°49'ю	24°44'з	6766–6875	27 (1100)	
5.XII	1971	895ДD	ЮС	56°49'ю	24°44'з	6875	12 (114)	8,88
5.XII	1971	898Т	ЮС	56°47,5'ю	24°57'з	6052–6150	43 (2060)	
14.XII	1971	914Т	м. Скотия Sc	56°20,5'ю	50°48'з	5650–6070	74 (4170)	
16.I	1972	1012Т	Ром	0°13'ю	18°29,8'з	7460–7600	20 (313)	
17.I	1972	1013Т	Ром R	0°08,2'ю	18°36'з	6330–6430	28 (236)	
17.I	1972	1014Т D	Ром	0°13,7'ю	18°37,2'з	7430–7500	10 (174)	
9.II	1973	1178-А Д	ПР pr	19°33'с h	68°09'з	8150	3 (3)	0,02
3.II	1973	1182Т	ПР	19°53'с	60°11'з	6400	16 (280)	

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Key:
e'. Four successful catches were made at depths from 7,540 to 7,960 m; there were various invertebrates and benthic fish
f'. Dmitriy Mendeleyev USSR

Columns 7/8:
18. For the first time benthic shrimp were caught deeper than 6 km. There is no other information about the catch.
19. 2 (several)
20. Benthic fish were caught. There is no other information about the catch.
21. Benthic octopi were caught.

Таблица (продолжение)

1		2	3	4	5	6	7	8
4.II	1973	1183T	ПР	19° 38,4′ с	67° 46,3′ з	8330	11 (310)	
7.II	1973	1187T	ПР P	19° 24′ с	68° 00,8′ з	5890–6000	11 (14)	
8.II	1973	1189T	ПР R	19° 38,8′ с n	68° 19′ з	7950–8100	8 (48)	
9.II	1973	1194ДD	ПР	19° 48,7′ с	68° 08′ з	w 6650	4 (7)	0,23
10.II	1973	1194T	ПР	19° 48,7′ с	68° 08′ з	6800–7030	11 (61)	
20.III	1973	1242-AT	Кайм (Б)	19° 00,6′ с	80° 29,5′ з	6800	17 (100)	
16.III	1973	1273T	Кайман (Б)	19° 00,7′ с	80° 35,4′ з	6840–6850	11 (20)	
16.III	1973	D 1243Д-1	Кайман (Б)	19° 01,4′с	80°36,8′ з	6910	2 (3)	0,06
16.III	1973	D 1243Д-2	Кайман (Б)	19° 03,8′ с	80° 35,7′ з	6950	4 (8)	0,03
22.III	1973	1259T	C A Кайман (Б)	19° 04,5′ с	80° 29,8′ з	5800–6500	16 (75)	
24.III	1973	1266T	Кайман (О)	19° 45,5′ с	76° 44,1′ з	5900–6300	10 (20)	
24.III	1973	D 1266Д	Кайман (О)	19° 45,3′ с	76° 43,2′ з	6300	2 (3)	0,01
25.III	1973	1267T	Кайман (О)	19° 38,6′ с	76° 37,5′ з	6740–6780	22 (450)	
25.III	1973	D 1267Д	Кайман (О)	19° 38,7′ с	76° 37,1′ з	6740	4 (4)	0,09
26.III	1973	D 1270Д	Кайман (О)	19°36,1′ с	76° 52,1′ з	6680	3 (43)	0,04
k "Джон Эллиот Пиллсбари" ("John Elliott Pillsbury"), США, 1967–1975 [Voss, 1967, 1969 и личное сообщение от 1.III.1971 г. d′ Staiger, 1969, 1972; Anonym, 1970a, b, c; Holthuis, 1971; Nielsen, 1977; Voss et al., 1977; Wolff, 1979]								
21.V	1967	575T	CA Кайман (Б)	17° 45′ с n	84° 22′ з w	6364–6373	18 Впервые глубже 6 км поймана придонная креветка. Других сведений об улове нет	
I	1969	?	P R ПР	e′ Проведено 4 удачных донных лова на глубинах от 7540 до 7960 м; пойманы различные беспозвоночные и придонная рыба				
?		811T	ПР	19° 26′ с n	66° 24′ з	w 7471		
26.VII	1969	993T	ПР	19°22,5′ с	66° 13,8′з	7315–7388	2 (несколько) 19	
21.I	1970	1168T	ПР	19°43′с	67° 05′з	8370	20 Поймана придонная рыба. Других сведений об улове нет	
?		1384T	ПР	n 19° 45′ с	w 67° 00′ з	7938	21	
	1975	?	C A Кайман (Б)	?	?	7280	Пойман донный осьминог	
f′ "Дмитрий Менделеев", СССР, 1969–1976								
16.III	1969	20T D	ПР PR	19°37′ с n	62° 21′ з	w 6290–6314	17 (80)	
30.VII	1972	542Д	Пер P	10° 32,6′ ю	79° 57,6′ з	6250	7 (27)	5,7
31.I	1976	1305T-1	Хьорт H	58° 46,4′ ю	157° 58,4′ в	6420–6650	3 (5)	
31.I	1976	1305T-2	Хьорт J	58° 48,4′ ю	157° 57,9′ в	6200–6230	5 (5)	
31.I	1976	1305ДD	Хьорт O	58° 51,1′ю S	157° 57,8′ в	e 6200	8 (12)	3,6
1.II	1976	1306T	Хьорт R	59° 11,9′ ю	158° 31,8′ в	6100–6210	7 (20)	
1.II	1976	1306Д D	Хьорт T	59° 12,8′ ю	158° 32′ в	6070	4 (17)	0,4

Page 162 (Continuation)

Additionally, based on the data of Hessler et al. [1978], the US Naval Electronics Laboratory (USNEL) expedition in the Philippine trench obtained a box corer sample deeper than 6 km (up to 9,600 km), while the Woods Hole Oceanographic Institution (WHOI) expedition obtained 8 catches with an epibenthic trawl line to depth 9,600 m.

*The work of [Tendal, Hessler, 1977] erroneously indicates stations N-30 and N-39 as made on the research vessel Argo in 1969.
**At all stations in the Philippine trench (except N-215) numerous Amphipoda of one species Hirondellea gigas were collected on bait. At station N-215 (depth less than 6 km) numerous fish and various Crustacea were gathered.

Key:

g'. An epibenthic trawl or anchor drag was used, the bottom grab collections were made by a box corer 0.25 m^2 with sieve washing of the samples with mesh 0.3 mm. At the stations in the Philippine, Mariana and Chile trenches descents were made to the bottom of an autonomous instrument-carrier with bait and camera or with traps containing bait.

h'. There were numerous Amphipoda of one species, Hirondellea gigas, at depths 7,353 to 10,592 m in the traps with bait.

k. United States

Columns 7/8

22. There are no data about the catches.
23. There are no data about the catches
24. (318 specimens of macro- and 538 specimens of meiofauna)
25. At all of these stations numerous Amphipoda were collected on the bait.
26. Bait with camera
27. Traps with bait. The 16 traps caught 4,322 Amphipoda specimens, Hirondellea gigas

Таблица (продолжение)

1	2	3	4	5	6	7	8
"Томас Вашингтон" ("Thomas Washington"), США, 1970–1975 k [Hessler, Jumars, 1974; Jumars, 1974; Jumars, Hessler, 1976; g′ Tendal, Hessler, 1977; Hessler et al., 1978; Erséus, 1979]							
Траления проводились эпибентическим тралом или якорной драгой, дночерпательные сборы – коробчатым дночерпателем 0,25 м² с промывкой проб на сите с ячеей 0,3 мм. На станциях в Фил, Мар и Чил желобах проводились спуски на дно автономного приборoносителя с приманкой и фотокамерой или с ловушками, содержавшими приманку							
x Экспедиция "Seventow"						22	
8.VII 1970	Н-30*Т	2 С-в котл То	30° 05′ с n	156° 11,8′ з w	6065–6079	Данных об улове нет	
8.VII 1970	Н-31Т	Там же	30° 03,5′ с	156° 12,7′ з	6044–6050	То же 6	
9.VII 1970	Н-32ДD	THE SAME „	30° 04,1′ с	156° 11′ з	6036	>20 (169) 23	
10.VII 1970	Н-33ДD	„	30° 02,5′ с	156° 13,1′ з	6040	Данных об улове нет	
10.VII 1970	Н-34ТD	„	30° 00,6′ с	156° 12,4′ з	6017–6029	Данных об улове нет 23	
20.VII 1970	Н-39*Д	Ал AL	50° 58′ с	171° 37,5′ з	7298	(318 экз. макро- и 24 538 экз. мейофауны)	
x Экспедиция "Southtow"							
		depth at latitude				25	
1972	143, 144 +и 145 ch	Чил, глубина 6767 м на широте 27° 06′ ю			S	На всех этих станциях на приманку собирались многочисленные амфиподы	
		depth at latitude					
	150	Чил, глубина 7196 м на широте 25° 13′ ю					
	153, 154	Чил, глубина 7023 м на широте 23° 33′ ю					
	162	Чил, глубина 6898 м на широте 20° 23′ ю					
x Экспедиция "Eurydice"							
II 1975	Н-176	Фил P L	10° 36,3′ с	126° 38,1′ в	9604	26 Приманка с фотокамерой	
	Н-186	Фил P	10° 36,5′ с n	126° 36,6′ в e	9604	27 Ловушки с приманкой. В 16 ловушках поймано 4322 экз. амфипод – Hirondellea gigas	
	Н-189Д D	Фил P L	10° 36′ с	126° 38′ в	9600		
	Н-191	Фил P	10° 37′ с	126° 37,7′ в	9605	26 Приманка с фотокамерой	
	Н-196Д D	Фил	10° 36′ с	126° 38′ в	9605		
	?	Фил	9° 02′ с	127° 03,5′ в	9806	26 Приманка с фотокамерой	
	Н-215**	SLOPE Склон Фил PL P	9° 53′ с	127° 43,8′ в h′	5861	То же 6	
1975 (?)		Мар M	В ловушки с приманкой на глубинах от 7353 до 10592 м попадались многочисленные амфиподы одного вида – Hirondellea gigas				

Кроме того, по данным Хесслера с соавторами [Hessler et al., 1978], экспедицией "USNEL" (U.S. Naval Electronics Laboratory) получено в Фил желобе глубже 6 км (до 9600 м) 13 проб коробчатым дночерпателем 0,25 м², а экспедицией "WHOI" (Woods Hole Oceanographic Institution) – 8 уловов эпибентическим тралом до глубины 9600 м.

*В работе [Tendal, Hessler, 1977] станции Н-30 и Н-39 ошибочно указаны как выполненные э/с "Argo" в 1969 г.

**На всех станциях в Фил желобе (кроме Н-215) на приманку собирались очень многочисленные амфиподы одного вида – Hirondellea gigas. На станции Н-215 (глубина менее 6 км) на приманку собирались многочисленные рыбы и различные ракообразные.

Page 163 Continuation

Data on the catches have only been published partially. For stations B-6 and B-4 there are preliminary lists of the mollusks; for the others, the number of specimens of different taxonomic groups (the last column from the right in the table: number of classes and in the parentheses, the number of specimens).

Key:
Column 3: 1. Northwest Pacific Ocean trough
Column 4: n= north
Column 5: e= east
w. Japan

i. ' Akademik Mstislav Keldysh, USSR
j'. Bottom grab samples were obtained by a box corer 0.25 m^2; the animals were taken from a sample area 0.09 m^2 that was washed on a sieve with mesh 0.5 mm. Data are cited about the number of species in the specimen and preliminary information about the catch composition. Four species of Isopoda and 1 species of Cumacea were defined from the trawling sample; there is no other information about the catch. Expeditions KN-80-1 and KN81-4.

Таблица (продолжение)

1	2	3	4	5	6	7	8

w

Сойо-Мару ("Soyo-Maru"), Япония, 1972–1980
[Okutani, 1974, 1982]

Данные об уловах опубликованы лишь частично. Для станций В-6 и В-4 приведены предварительные списки пойманных моллюсков; для остальных – число экземпляров различных систематических групп (последняя графа справа в таблице: число классов и в скобках число экземпляров) 22

1	2	3	4	5	6	7	8
22.VI 1972	В-6Т	ИБ I	29° 58,8′ с	142° 59,3′ в	7500	Данных об улове нет	
21.VI 1973	В-4Т	ИБ B	30° 04,2′ с	142° 50,3′ в	7530	То же 6	
2.VII 1978	R-21Т	С-з котл То	29° 19,6′ с	147°27′ в	6320–6340	6 кл (33)	
4.VII 1978	R-22Т	С-з котл То	28° 17,8′с	143° 58′ в	6340	6 (16)	
24.VII 1979	R-30Т	С-з котл То	30° 07,8′ с	147° 08,2′ в	6190	11 (33)	
7.VII 1979	R-37Т	Мар M	13°38,4′с	146° 50,6′ в e	8870	22 Данных об улове нет	
21.VI 1980	R-46Т	С-з котл То	30° 52,2° с	146° 03,9′ в	6090	6 (28)	
22.VI 1980	R-47-1Т	С-з котл То	29° 47,2′ с n	147° 11′ в	6210	5 (17)	
23.VI 1980	R-47-2Т	С-з котл То	29° 42′ с	147° 15,6′ в	6205	2 (12)	
24.VI 1980	R-47-3Т	С-з котл То	30° 05,6′ с	147° 09,4′ в	6180	4 (33)	
25.VI 1980	R-47-4Т	С-з котл То	30° 10,2′ с	147° 30,2′ в	6010	3 (14)	
26.VI 1980	R-47-5Т	С-з котл То	30° 06,7′ с	146° 53, 3′ в	6190	5 (10)	
26.VI 1980	R-47-6Т	С-з котл То	30° 02,9′ с	146° 53,3′ в	6210	5 (11)	
27.VI 1980	R-47-7Т	С-з котл То	30° 17,2′ с	146° 54,2′ в	6170	5 (14)	
28.VI 1980	R-47-9Т	С-з котл То	29° 48′ с	146° 56,3′ в	6160	4 (4)	
29.VI 1980	R-47-10Т	С-з котл То	29° 42,1′ с	146° 53,2′ в	6180	6 (17)	

k

"Джиллис" ("Gillis"), США, 1975
[Madsen, 1981]

1	2	3	4	5	6	7	8
VII 1975	121Т	CAY Кайм (О)	19° 38′ с	76° 20,2′з	6466–6660	SPEC. OF ONE SPECIES OF STARFISH 435 экз. одного вида морских звезд; других 22 данных об улове нет	

i'

"Академик Мстислав Келдыш", СССР, 1981

1	2	3	4	5	6	7	8
20.III 1981	D 22Д	CAN TRENCH Канарс котл	21° 20′ с n	38° 20,3′ з w	6120	3 (2)	0,065

w

"Хакухо-Мару" ("Hakuho-Mary"), Япония, 1980, 1981
[Gamô, 1983, 1985; Shin, 1984; Kristensen, Shirayama, 1988]

j'

Дночерпательные пробы получены коробчатым дночерпателем 0,25 м²; животных выбирали из части пробы площадью 0,09 м², которая промывалась на сите с ячеей 0,5 мм. Приведены данные о числе видов и экземпляров и предварительные сведения о составе улова. Из траловой пробы определены 4 вида изопод и 1 вид Cumacea; других сведений об улове нет. Экспедиции "КН-80-1" и "КН-81-4"

1	2	3	4	5	6	7	8
3.III 1980	9Д	ИБ IB	28° 28,3′с	143° 19,6′в e	8260		
31.VII 1981	12Т	J Япон	38° 34,4′ с	144° 19,8′ в	6380–6450		
	12Д	A Япон	38° 32,2′ с	144° 19,9′ в	6380	6 (13)	
	13Д	P Япон	38° 31′ с	144° 06,5′ в	7460	6 (29)	

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Key:
Column 1:
k'. Date and No. of station not indicated
l'. Submarine Nautile, France

Columns 7/8:
1. The finding of mollusk Spinula oceanica is indicated
2. Clusters of Bivalvia Calyptogena were found (population density 400-1500 specimens/m^2, biomass 24-51 kg/m^2) living because of bacterial chemosynthesis based on the energy from oxidation of thermogenic methane contained in the seepage water.

Таблица (окончание)

1	2	3	4	5	6	7	8
"Кайо-Мару" ("Kaiyo-Maru"), Япония [Okutani, 1974]							
Дата и № станции не указаны		С-з котл То	30° 02′ с	146° 15′	6200	Указано нахождение моллюска Spinula oceanica	1
Подводное исследовательское судно "Наутилус" ("Nautile"), Франция, 1985 [Lallemant et al., 1986; Laubier et al., 1986; KAIKO II, 1987]							
22.VII 1985	KD14	JAP Япон	35° 54,2′ с	142° 30,7′ в	5640–5695	Обнаружены скопления двустворчатых моллюсков Calyptogena (плотность поселений 400–1500 экз./м², биомасса 24–51 кг/м²), живущих за счет бактериального хемосинтеза, основанного на энергии, получаемой путем окисления термогенного метана, содержащегося в водах высачивания	2
31.VII 1985	KD18	Япон	40° 06,3′ с	144° 10,6′ в	5653–5960		
3.VIII 1985	KD21	КК	41° 18,5′ с	144° 48,3′ в	5131–5785		
5.VII 1985	KD23	JAP Япон	40° 06,5′ с	144° 10′ в	5479–5660		

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APPENDIX II.

LISTS OF DWELLERS AT DEPTHS OVER 6,000 m

The surnames in the "Source" column without indication of the year refer to pre-analyses submitted to me by zoology specialists for various taxonomic groups. The surnames in parentheses after the reference to the cited source are the authors of the analysis that were used in this work.

TABLE 1

Key:

1. Benthic Foraminifera found in the Pacific Ocean at depths over 6,000 m [per Saidova, 1975*]
a. No. in order
b. species
c. depth of dissemination, m
d. trenches and troughs in which found below 6,000 m
e. dissemination at depths less than 6,000 m
f. order
g. family

column 4:
2. northwest trough
3. northeast trough

*The data of this work are based on a study of Foraminifera not only from the biological trawling and bottom grab collections of the Soviet expeditions, but also from the geological dredging samples obtained at many stations and from the surface layer of the benthic sediment taken by the core samplers. In a number of cases, the indicated limits of vertical dissemination of the species do not agree with the depth of the sample-taking at the stations noted for this species, but it is impossible to establish in precisely which case the error was allowed. The depths are therefore always indicated by the main lists of species by orders (Tables 1-11).
**The species are widespread in the Pacific Ocean.

Приложение II

СПИСКИ ЖИВОТНЫХ, ОБИТАЮЩИХ НА ГЛУБИНАХ БОЛЕЕ 6000 М

Фамилии, помещенные в графе "Источник" без указания года, относятся к предварительным определениям, предоставленным мне специалистами-зоологами по различным систематическим группам. Фамилии, помещенные в скобках после ссылки на литературный источник, – авторы, определения которых были использованы в указанной работе.

Таблица 1

Донные фораминиферы – Foraminifera, найденные в Тихом океане на глубинах более 6000 м [по: Саидова, 1975*]

№ п/п a	Вид b	Глубина распространения, м c	Желоба и котловины, в которых найден глубже 6000 м d	Распространение на глубинах менее 6000 м e
1	2	3	4	5
	f **Отряд Allogromida**			
	g Семейство Allogromiidae			
1.	Nodellum membranacea (Brady)	2140–7224	С-з котл 2	То**
2.	Xenothekella elongata Saidova	9220–9380	КК	–
	f **Отряд Ammodiscida**			
	g Семейство Ammodiscidae			
3.	Ammodiscus consonus Saidova	4710–9050	КК	nw с, з То
4.	A. profundissimus Saidova	3400–9220	С-з котл 2, С-в котл 3	То
5.	Ammolagena clavata (Jones et Parker)	68–7660	Ал AL	То
6.	Glomospira gordialis (Jones et Parker)	2507–9050	КК, С-з котл, 2 С-в котл 3	То
7.	Turritellella shoneana (Siddall)	?–7225	Япон JAP	nw с-з То
8.	Usbekistania charoides profunda Saidova	2532–6520	Ал, Рюкю, С-з котл, С-в котл AL RYU 2 3	То
	g Семейство Lituolidae			
9.	Adercotryma glomerata abyssorum Saidova	2000–7351	КК, С-з котл, 2 С-в котл 3	То
10.	Ammobaculites echinatus echinatus Saidova	2414–7316	КК, С-з котл, 2 С-в котл 3	То
11.	A. filiformis Earland	1669–6180	КК	То
12.	A. microformis Saidova	5080–6250	КК	n с То
13.	A. tenuimargo (Brady)	7225	Япон JAP	–
14.	Ammobaculites sp.	640–6520	Ал AL	e в То
15.	Cribrostomellus apertus Saidova	8220–9580	КК	–
16.	Cribrostomoides nitidum abyssalicus Saidova	2000–6250	КК, С-в котл 3	То

---

* Данные этой работы основаны на изучении фораминифер не только из биологических траловых и дночерпательных сборов советских экспедиций, но также из полученных на многих станциях геологических дночерпательных проб и из поверхностного слоя донных осадков, взятых грунтовыми трубками. В ряде случаев указанные границы вертикального распространения вида не согласуются с глубинами взятия проб на отмеченных для этого вида станциях, но установить, в каком именно случае допущена ошибка, невозможно. Поэтому глубины везде указаны по основным перечням видов по отрядам (табл. 1–11).

** Вид широко распространен в Тихом океане.

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***The question mark hereinafter means that the stations at which the species were found below 6,000 m are not indicated.

Таблица 1 (продолжение)

1	2	3	4	5
17.	C. profundum Saidova	2380–6240	AL Ал, КК, С-з 2 котл, С-в котл, 3 ИБ IB	То
18.	C. rotulatum (Brady)	2508–7266	AL Ал, КК, С-в 3 2 котл	То
19.	C. scitulus (Brady)	1450–6006	?*** 2	То
20.	Cyclammina trullissata (Brady)	3000–6200	С-з котл, С-в 3 котл	То
21.	C. subtrullissata (Parr)	2770–6240	?	То
22.	C. cancellata cancellata Brady	2750–6200	КК, С-з 2 и С-в 2 котл	То
23.	Eratidus foliaceus (Brady)	1015–6250	КК	То
24.	Haplophragmoides bradyi (Robertson)	1732–6050	С-з котл 2	То
25.	H. pulicosus Saidova	2611–6740	КК, С-з котл 2	То
26.	Labrospira canariensis profunda Saidova	1739–6250	КК	То
27.	Recurvoidatus parcus Saidova	4105–8087	КК, VOLC Волк, С-з 2 котл	То
28.	R. trochamminiformis trochamminiformis Saidova	2726–6740	КК, ИБ, С-з 2 котл	То
29.	R. ultraabyssalicus Saidova	6700–7678	КК, Буг BG	–
30.	Recurvoides contortus gurgitis Saidova	1500–6740	КК, С-з и С-в 3 котл 2	То
31.	R. mutilus Saidova	7225–8380	JAP Япон, VOLC Волк, Буг BG	–
32.	Trochamminoides lituotubus Saidova	750–6250	?	То
	9 Семейство Morulaeplectidae			
33.	Morulaeplecta sp.	1950–6980	Ал	n с То
	9 Семейство Spiroplectamminidae			
34.	Spiroplectammina subcylindrica Earland	2000–6810	Рюкю	То
	f Отряд Astrorhizida			
	9 Семейство Astrorhizidae			
35.	Astrorhizinulla aetheria Saidova	4610–6250	КК	n с То
36.	Psammosiphonella beata (Saidova)	1887–9540	AL Ал, КК, BG Буг, С-з котл 2	То
37.	P. bougainwillica Saidova	6800–8006	Буг BG	–
38.	P. rustica (Folin)	2680–6150	JAP Япон, С-з 2 котл	n с То
39.	Rhabdammina bougainwillica Saidova	9022	Буг BG	–
40.	R. inaudita Saidova	2000–6260	КК, С-з котл 2	То
41.	R. parabyssorum Stschedrina	2020–6860	То же THE SAME	n с То
42.	R. recondita Saidova	3429–6880	”	n с То
	9 Семейство Hormosinidae			
43.	Aschemonella delicata Saidova	3420–6070	С-з котл 2	n с То
44.	A. ramuliformis Brady	2998–8950	Кер	SW ю-з То
45.	A. scabra Brady	2760–7180	КК (?), С-з 2 котл	n с То
46.	Hormosina normani Brady	1620–7266	AL Ал, С-з котл 2	То
47.	Hormosinella distans distans (Brady)	1134–7660	КК?	То
48.	Reophanus oviculus oviculus (Brady)	1620–7225	?	То

*** Знак вопроса здесь и далее означает, что станции, на которых вид найден глубже 6000 м, не указаны.

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****Tendal and Hessler [1977] include the genus Normanina in their established family Komkiidae which they classify as the order Textulariida.

Таблица 1 (продолжение)

1	2	3	4	5
49.	Saccamminis incrusatum Saidova	3360–8006	КК, Буг BG, С-з котл 2	То
50.	Tholosina irregularis Rhumbler	6070–10002	Япон JAP, Буг BG, Кер, С-з котл 2	–
	g Семейство Hyperamminidae			
51.	Bathysiphon lanosum Saidova	500–6240	С-з котл 2	n с То
52.	Hyperammina echinata Saidova	2930–9580	КК, Рюкю RYU, С-з 2 котл	nw с-з То
53.	H. elongata elongata Brady	2048–6980	Ал AL	То
54.	H. imbecilla Saidova	2200–6072	С-з котл 2	То
55.	H. kermadecensis Saidova	8950–10002	Кер	–
56.	H. zenkevichi Saidova	5060–9540	КК	КК
57.	Protobotellina pacifica Saidova	2000–8430	Ал AL, КК, С-з 2 котл	n с То
58.	Saccorhiza praealta Saidova	4120–6870	КК	То
59.	S. ramosa (Brady)	1739–6072	КК, С-з котл 2	n с То
60.	S. zenkevichi Saidova	6700–9540	КК	–
	g Семейство Reophacidae			
61.	Hormosinoides perpastus Saidova	6070	С-з котл 2	–
62.	Nodosinum gaussicum (Rhumbler)	4580–7180	Ал AL, КК, Япон JAP, ИБ IB, С-з котл 2	n с То
63.	Pseudonodosinella bacillaris (Brady)	2853–7500	Ал AL, КК, С-з 2 и С-в 3 котл	То
64.	P. nodulosa (Brady)	2561–9540	Ал AL, КК, Буг BG, НГ NH, С-в котл 3	То
65.	P. rubra Saidova	3540–6120	С-з котл 2	n с, w з То
66.	Reophax dentaliniformis Brady	2140–9220	Ал AL, КК, С-з 2 котл, Чил Ch	То
67.	R. echinatus Saidova	4920–6070	С-з котл 2	n с То
68.	R. excentricus Cushman	1739–6250	С-з котл 2	То
69.	R. pesciculus Saidova	8220–9580	КК	–
70.	Subreophax aduncus (Brady)	2515–7225	?	То
	g Семейство Rhizamminidae			
71.	Dendrophrya abyssalica Saidova	5510–6060	С-з котл 2	n с То
72.	D. kermadecensis Saidova	8950–10002	Кер	–
73.	Normanina elongata Saidova****	2890–7180	КК, С-з котл 2	n с То
74.	N. fructuosa Saidova	4300–7180	Ал AL, КК, С-з 2 котл	n с То
75.	N. ultraabyssalica Saidova	8950–10687	Тон TON, Кер	–
76.	Rhizammina algaeformis Brady	1015–6240	?	То
77.	R. alta Saidova	5050–6520	Ал AL, КК, С-з 2 котл	n с То
78.	R. transversa Saidova	6020–6070	С-з котл 2	–
	g Семейство Saccamminidae			
79.	Pelosina cylindrica Brady	3429–6240	Кер?	То
80.	P. rotundata Brady	3400–6070	С-з котл 2	n с То
81.	P. variabilis Brady	1760–6980	Ал AL, КК	n с То
82.	Pelosphaera trunca Saidova	6070	С-з котл 2	–

****Тендал и Хесслер [Tendal, Hessler, 1977] включают род Normanina в установленное ими семейство Komokiidae, которое они относят к отряду Textulariida.

Page 168 Continuation

Additionally, in Saidova's later work [1976, p. 63] a finding is mentioned in the Kuril-Kamchatka trench of young, live Foraminifera with secretion shell of another two species: order Rotaliida, Melonis.sp at depths 6,250 and 6,700 m and Gyroidina sp. at depth 8,220 m.

Таблица 1 (окончание)

1	2	3	4	5
83.	Proteanella alta Saidova	1724–6860	КК, С-з котл 2	То
84.	P. minuta Saidova	8220–9220	КК	–
85.	Psammosphaera orbiculata Saidova	2532–6070	С-з котл 2	n c с, ц То
86.	Sorosphaera abyssorum (Saidova)	2582–10687	VOLC TON Волк, Тон, Ch Чил, С-з котл 2	То
87.	Thurammina albicans Brady	1800–7720	Чил Ch	e в То
88.	T. corrugata Earland	2140–7720	Чил	в То
	g Семейство Schizamminidae			
89.	Astrorhizinella planata Saidova	6860–7320	КК	–
	f Отряд Ataxophragmiida			
	g Семейство Ataxophragmiidae			
90.	Eggerella bradyi bradyi (Cushman)	1748–6250	КК	То
	g Семейство Trochamminidae			
91.	Conotrochammina abyssorum Saidova	2507–7300	КК, С-в котл 3	То
92.	Cystammina pauciloculata (Brady)	252–6200	RYU Рюкю, С-в 3 котл	То
93.	Gaudrynoides spicularum (Cushman)	2862–7225	RYU Рюкю, С-в 3 котл	То
94.	Globotextularia anceps (Brady)	2507–6065	С-в котл 3	То
95.	Tritaxis nana (Brady)	1550–6070	С-з котл 2	То
96.	Trochammina alta Saidova	713–6008	?	То nw
97.	T. abyssorum Saidova	3314–9220	КК	с-з То
98.	T. macroformis Saidova	5017–6860	КК, С-з котл 2	n с То
99.	T. subglabra Saidova	1800–6250	КК	То
	f Отряд Miliolida			
	g Семейство Fischerinidae			
100.	Cornuspiroides striolatus (Brady)	2197–6240	КК	То
	g Семейство Miliolidae			
101.	Involvohauerina globularis Loeblich	5030–6150	JAP 2 Япон, С-з котл	nw с-з То
102.	Miliolinella laeva Saidova	2048–7225	N НГ, С-з котл 2	То
103.	Pseudospirillina abyssalica Saidova	4930–6927	N НГ	с, з То n k

Кроме того, в более поздней работе Саидова [1976, с. 63] упоминает о нахождении в Курило-Камчатском желобе молодых особей живых фораминифер с секреционной раковиной еще двух видов: отряд Rotaliida – Melonis sp. на глубинах 6250 и 6700 м и Gyroidina sp. на глубине 8220 м.

TABLE 2.

BENTHIC FORAMINIFERA FOUND IN TWO BOTTOM GRAB SAMPLES FROM THE ALEUTIAN TRENCH OBTAINED ON THE RESEARCH VESSEL VITYAZ FROM DEPTHS 6,520 AND 6,980 m

(per Khusid, 1973 and additional data of this author)

Key:
a. No. in order
b. Species
c. Depth, m
d. Order
e. Family

Таблица 2

Донные фораминиферы – Foraminifera, найденные в двух дночерпательных пробах из Алеутского желоба, полученных э/с "Витязь" с глубин 6520 и 6980 м (по: Хусид, 1973 и дополнительным данным этого автора)

№ п/п a	Вид b	c Глубина, м	
		6520	6980
	d Отряд Ammodiscida		
	e Семейство Ammodiscidae		
1.	Usbekistania charoides (Brady)	+	–
	e Семейство Lituolidae		
2.	Adercotryma glomerata (Brady)	+	+
3.	Ammobaculites sp.	+	–
4.	Cribrostomoides subglobosus (Brady)	+	–
5.	Haplophragmoides pulicosus Saidova	+	+
6.	Recurvoidatus parcus Saidova	–	+
	e Семейство Morulaeplectidae		
7.	Morulaeplecta sp.	–	+
	d Отряд Astrorhizida		
	e Семейство Astrorhizidae		
8.	Astrorhizinulla sp.	–	+
9.	Pseudomarsipella sp.	+	–
	e Семейство Hormosinidae		
10.	Tholosina bulla (Brady)	+	–
	e Семейство Hyperamminidae		
11.	Hyperammina elongata Brady	–	+
12.	Saccorhiza ramosa (Brady)	+	+
	e Семейство Reophacidae		
13.	Reophax dentaliniformis Brady	+	+
	e Семейство Rhizamminidae		
14.	Dendrophrya abyssalica Saidova	+	–
15.	Rhizammina algaeformis Brady	+	–
16.	Rh. alta Saidova	+	–
	e Семейство Saccamminidae		
17.	Lagenammina sp.	+	–
18.	Pelosina variabilis Brady	–	+
19.	Proteanina alta (Saidova)	+	–
20.	Pseudomarsipella sp.	+	–
21.	Saccammina alta Saidova	+	–
22.	Sorosphaera abyssorum (Saidova)	+	–
	d Отряд Ataxophragmiida		
	e Семейство Ataxophragmiidae		
23.	Eggerella brady (Cushman)	+	–
	e Семейство Trochamminidae		
24.	Conotrochammina abyssorum Saidova	+	–
25.	Trochammina alta Saidova	+	+
26.	T. subglabra Saidova	+	+
27.	Trochammina sp.	–	+
	d Отряд Lagenida		
28.	Lagena sp.	–	+
	d Отряд Rotaliida		
29.	Pullenia sp.	+	–
	d Отряд ?		
30	Miliammina sp.	+	–

TABLE 3.
SPONGIA

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at lower depths
h. Minimum depth, m
i. Region of occurrence
j. Source
l. Family
m. Order
n. Class

Column 3:
1. Northeast trough

Column 8:
1. Koltun
2. Zenkevitch
3. Analyses by V. M. Koltun
4. The same
5. Vinogradova et al, Beliaev, Mironov

Таблица 3

Губки – Spongia

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
a	b						j
1	2	3	4	5	6	7	8
	n Класс Hyalospongia						
	m Отряд Amphidiscophora						
	l Семейство Hyalonematidae						
1.	Hyalonema apertum Schulze	КК 1 С-в котл То	6090–6235 6272–6282	"B"(1) "B"(1)	204	То, Ио IN	Колтун, 1970 1
2.	Hyalonema sp.	КК	6860	"B"(1)			Зенкевич и др., 1955 2
	m Отряд Hexasterophora						
	l Семейство Caulophacidae						
3.	Caulophacus hadalis Lévi	Кер	6660–6770	"Gal"(1)	–	–	Lévi, 1964
4.	C. latus latifolium Ijima	КК	6090–6710	"B"(2)	572	с-з То NW	Колтун, 1970 1
5.	Caulophacus sp.sp.	Япон JAP 1 С-в котл То 2 С-з котл То	6156–6207 6051 6272–6282	"B"(1) "B"(1) "B"(1)			Определения 3 В.М. Колтуна
	l Семейство Euplectellidae						
6.	Holascus undulatus Schulze	Ал AL 1 С-в котл То	6296–6328 6272–6282	"B"(1) "B"(1)	2868	n с То	Колтун, 1970 1
	l Семейство Rossellidae						
7.	Bathydoris fimbriatus Sculze	КК	6090–6135	"B"(1)	2167	То, Ио, IN Ао	То же 4
8.	Hyalospongiae (ближе не определенные) NOT DEFINED CLOSER	Волк VOLC ЮС SS м. Скотия SC	8530–8540 6766–7216 5650–6070	"B"(1) "AK"(2) "AK"(1)			Виноградова и др., 1974; Беляев, Миронов, 1977а 5
	n Класс Demospongia						
	m Отряд Cornacuspongida						
	l Семейство Chondrocladiidae						
9.	Chondrochadia concrescens (Schmidt)	КК	6090–8660	"B"(2)	200	То, Ио, IN Ао	Колтун, 1970 1
10.	Ch. dichotoma Lévi	1 С-в котл То	6272–6282	"B"(1)	3310	n с То, Ио IN	То же 4
	l Семейство Cladorhizidae						
11.	Asbestopluma biserialis (Ridley et Dendy)	1 С-в котл То	6272–6282	"B"(1)	2640	То	"

Key:
6. Beliaev, Mironov

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Additionally, Spongia (not defined more closely) have been found in the following trenches: Peru at depths 6,006-6,328 m (Vema, st. 154; Elt, st. 37; AK, st. 394, 296); Tonga 8,950-9,020 m (Vityaz, st. 6,327); Romanche 6,330-7,340 m (AK, st. 9, 1013); PR 6,290-6,314 m (DM, st. 20); SS 6,052-6,152 m (AK, st. 898) central Pacific Ocean trench 6,400 m (Vityaz, st. 6275-2).

Таблица 3 (окончание)

1	2	3	4	5	6	7	8
12.	A. occidentalis (Lambe) (включая A. hadalis Lévi)	Кер КК	6960–7000 7265–8840	"Gal"(1) "B"(4)	820	То	Lévi, 1964; Колтун, 1970 1
13.	A. wolffi Lévi	Кер КК	6620–6730 6675–8120	"Gal"(1) "B"(2)	4350	S ю Ио	То же 4
14.	Asbestopluma sp. sp.	КК 1 С-в котл То Фил PL	6860 6065 8440–9990	"B"(1) "B"(1) "B"(2)			Определения 3 В.М. Колтуна; Беляев, Миронов, 6 1977a
15.	Cladorhiza longipinna Ridley et Dendy	С-з котл 2 То 1 С-в котл То	6096 6065–6282	"B"(1) "B"(2)	3000	n c с, ц То	Колтун, 1970 1
16.	C. rectangularis Ridley et Dendy	1 С-в котл То	6065	"B"(1)	3325	n c с, ц То	То же 4
17.	C. septemdentalis Koltun	КК	7265–7295	"B"(1)	4891	nw с-з То	>
18.	Cladorhizidae sp. sp.	ИБ IB Мар M Яп YAP Пал P Пал L Фил PL НБ NB	6770–6890 8215–8225 7230–7280 7000–7170 8021–8042 7000–7880 7875–7921	"B"(2) "B"(1) "B"(1) "B"(1) "SpFB" "B"(2) "SpFB"	 P (1–Ф) P (1–Ф)		Lemche et al., 1976; Беляев, 6 Миронов, 1977a (определения 3 В.М. Колтуна)
	l Семейство Esperiopsidae						
19.	Esperiopsis plumosa Tanita	КК	6860	"B"(1)	SUB- Сублитораль LITORAL	JAP. SEA Японское м, с-з То nw	Колтун, 1970 1
	l Семейство Mycalidae						
20.	Abyssocladia bruuni Lévi	BG Буг	6920–7567	"B"(1)	5230	Кер	То же 4
21.	A. claviformis Koltun	2 С-з котл То	6096	"B"(1)	5005	КК	"
22.	A. oxeata Koltun	2 С-з котл То	6107–6127	"B"(1)	–	–	"
	m Отряд Tetraxonida						
	l Семейство Polymastiidae						
23.	Polymastia sol pacifica Koltun	1 С-в котл То	6065	"B"(1)	3940	n с То	"

Кроме того, губки (ближе не определенные) найдены в желобах: Пер – на глубинах 6006–6328 м ("Vema", ст. 154; "Elt", ст. 37; "АК", ст. 294, 296); Тон – 8950–9020 м ("В", ст. 6327); Ром – 6330–7340 м ("АК", ст. 9, 1013); ПР – 6290–6314 м ("ДМ", ст. 20); ЮС – 6052–6152 м ("АК", ст. 898); центр. котл То – 6400 м ("В", ст. 6275–2).

TABLE 4
COELENTERATA

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
l. Family
m. Order
n. Class

1. Northwest trench

Column 8:
1. Analysis of D. V. Naumov
2. Zenkevitch et al.,
3. The same
4. Kepler et al.
5. Naumov

Таблица 4

Кишечнополостные – Coelenterata

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
1	2	3	4	5	6	7	8
			n Класс Hydrozoa				
			m Отряд Leptolida				
		NH	l Семейство Branchiocerianthidae			IN	
1.	Branchiocerianthus imperator (Allman)	НГ.	6758–6776	"SpFB"(1)	Абиссаль ABYSSAL	То, Ио	Lemche et al., 1976*
2.	Branchiocerianthus sp.	Пер	6260	"AB"(1)			Menzies et al., 1973**
3.	Branchiocerianthus sp.	С-з котл То	6090	"B"(1)			Определение Д.В. Наумова
			l Семейство Lafoeidae				
4.	Cryptolaria sp.	КК	6860	"B"(1)			Зенкевич и др., 1955 2
5.	Halisiphonia galatheae Kramp	Кер	8210–8300	"Gal"(1)	–	–	Kramp, 1956
			l Семейство Plumulariidae			S IN	
6.	Aglaophenia tenuissima Ball	Кер	6660–6770	"Gal"(1)	293	ю Ио	То же 3
7.	Aglaophenia (?) galatheae Kramp	Яв Y	6900–7000	"Gal"(1)	–	–	"
8.	Aglaophenia sp.	CA Кайм (О)	6300	"AK"(1)			4 Келлер и др., 1975
			l Семейство Mitrocomidae?				
9.	Leptomedusae sp.	НБ NB	8258–8260	"SpFB"(1)			Lemche et al., 1976*
			l Семейство ?				
10.	Anthomedusae sp.	НБ NB	8258–8260	"SpFB"(1)			То же 3
			m Отряд Trachylida				
			l Семейство Rhopalonematidae (Trachymedusae)				
11.	Crossota (?) sp.	Пал PL НГ NH	8021–8042 6758–6776	"SpFB" (1–12ф) P "SpFB" (1–2ф) P			" 5
12.	Voragonema profundicola Naumov	КК	8700–6800***	"B" St. (cf. 5626)	–	–	Наумов, 1971
13.	Trachymedusae sp.	НБ NB	7057–7075	"SpFB"(1)			Lemche et al., 1976*
			n Класс Scyphozoa				
			m Отряд Coronata			IN	
14.	Stephanoscyphus simplex Kirkpatrick	Бан B Кер	6490–6650 6180–7000	"Gal"(1) "Gal"(3)	430	То, Ио, Ао	Kramp, 1959

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Key:
o. Subclass

Column 8:
6. Beliaev, Mironov
7. data of field logs
8. Pasternak

Таблица 4 (продолжение)

1	2	3	4	5	6	7	8
15.	Stephanoscyphus sp. sp.	AL Ал, КК, JAP Япон, ИБ, IB RYU Рюкю, Фил, PLP NG НГ, Кер, Центр C TRENCH котл То, P Пер, Чил, Ch PR ПР, Кайм, CAY Канарская котл. CN TROUGH Ао	6000–10000 6120–8150	over "В" (более 20), "АК"(4) "Elt"(2) DM "ДМ"(1), "АК"(7), "АМК"(1)			Беляев, 1966б, 6 1972; Беляев, Миронов, 1977а; Menzies, 1963; Келлер и др., 1975; 4 данные полевых журналов 7
			m Отряд Discomedusae				
16.	Ulmaridae sp. sp.	Буг BG	7847–8662	"SpFB" (1–7ф) p			Lemche et al., 1976*
			n Класс Anthozoa				
			o Подкласс Octocorallia				
			m Отряд Alcyonaria				
17.	?Clavulariidae	НБ NB Буг BG НГ NH	7057–8260 7847–8662 6758–6776	"SpFB" (2–2ф) p "SpFB" (1–1ф) p "SpFB" several (1–неск.ф) p			Lemche et al., 1976*
18.	?Telestidae	НБ NB	8258–8260	"SpFB" (1–неск. ф) several p			То же 3
			m Отряд Gorgonaria				
			l Семейство Primnoidae				
19.	Primnoella sp.	Пал PL	8021–8042	"SpFB" (1–ф) p			То же 3
			m Отряд Pennatularia				
			l Семейство Kophobelemnonidae				
20.	Kophobelemnon biflorum Pasternak****	КК	6090–6135	"В"(1)	2265	ne с, в То, S ю Ао (Ант)	Пастернак, 1970, 8 1975
21.	K. molanderi Pasternak	ЮС SS м Скотия Sc	6052–6150 5650–6070	"АК"(1) "АК"(1)	290	S ю Ао (Ант) ANT	Пастернак, 1975 8
			l Семейство Umbellulidae				
22.	Umbellula lindahli Kölliker	Пер P ЮС SS м Скотия Sc	6100 6052–6150 5650–6070	"АВ"(1) "АК"(1) "АК"(1)	223	IN Ао, Ио, Ант ANT	Menzies et al., 1973* Пастернак, 1975 8
23.	U. magniflora Kölliker	КК Пер P	6090–6135 6040–6240	"В"(1) "АК"(2)	77	То, IO S ю Ио, Ант ANT	Пастернак, 1970, 8 1975
24.	U. thomsoni Kölliker	КК Пер P	6090–6235 6040–6240	"В"(1) "АК"(2)	1336	То, Ио, IN Ао, Ант ANT	То же 3
25.	Umbellula sp. sp.	Кер Пер P	6180–6730 6006–6260	"Gal"(2) "Elt"(1) "АВ"(2ф)			Madsen, 1956a; Wolff, 1960; Menzies, 1963; Menzies et al., 1973*
26.	? Pennatularia	НБ NB	7875–7921	"SpFB" (1–много ф) many p			Lemche et al., 1976*

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Key:
Column 8.
9. F. A. Pasternak
10. Beliaev, Sokolova
11. Beliaev
12. Vinogradova
13. Beliaev, Mironov

Таблица 4 (продолжение)

1	2	3	4	5	6	7	8
			o *Подкласс* Hexacorallia				
			m Отряд Actiniaria				
27.	? Actiniidae	НБ NB	7057–7075	"SpFB" (1–1ф)			То же 3
		NH НГ, СК	6758–8930	"SpFB" (2–неск. ф) several			
			l Семейство Actinosto P lidae				
28.	Bathydactulus kroghi Carlgren	Кер	8210–8230	"Gal"(1)	–	–	Carlgren, 1956
29.	Hadalanthus knudseni Carlgren	Кер	6660–6770	"Gal"(1)	–	–	То же 3
			l Семейство Bathyphellidae				
30.	Daontesia mielchei Carlgren	B Бан	7250–7290	"Gal"(1)	–	–	"
			l Семейство Edwardsiidae				
31.	Paredwardsia lemchei Carlgren	Y Яв	7160	"Gal"(1)	–	–	"
			l Семейство Galatheanthemidae				
32.	Galatheanthemum hadale Carlgren	PLP Фил	9820–10210	"Gal"(3)	–	–	Carlgren, 1956;
		КК	7210–7230	"B"(1)			Ф.А. Пастернак***** 9
33.	G. profundale Carlgren	Кер	6180–8300	"Gal"(5)	4000	Ант	Carlgren, 1956; Dunn, 1983
34.	Galatheanthemum sp. n.******	Мар M	10170–10730	"B"(3)	–	–	Беляев, Соколова, 10 1960а; Беляев, 13 Миронов, 1977а
35.	Galatheanthemidae sp. sp.	Ал AL	6965–7250	"B"(3)			Suyehiro et al., 1962;
		КК	6090–7295	"B"(6)			Беляев, 1966б, 1972; 11
		Япон JAP	6156–7370	"B"(4)			Voss, 1969; Heezen.
				"RM"(1)			Hollister, 1971*;
		Рюкю RYU	6660–6670	"B"(1)			Виноградова 12
		ИБ IB	6770–9735	"B"(3)			и др., 1974;
		Волк VOLC	6780–6785	"B"(1)			
		Мар M	8215–8225	"B"(1)			
		Яп YAP	8560–8720	"B"(1)			Келлер и др., 1975; 4
		Фил PL	7420–9750	"B"(3)			Lemche et al., 1976*;
		Буг BG	6920–8662	"B"(2)			Беляев, Миронов, 13
				"SpFB" (1–2ф) P			1977а
		НГ NH	6758–6776	"SpFB" (1–1ф)			
		Тон TON	8950–9020	"B"(1)			
		Кер	8928–9174	"B"(1)			
		Чил Ch	7720	"AK"(1)			
		ПР PR	7950–8100	"AK"(1)			
			7500–8143	"JEP" (неск.) several			
		CAY B Кайм (B)	5800–6500	"AK"(1)			
		м Скотия SC	5650–6070	"AK"(1)			

Page 175 Continuation

*Analyses by underwater photographs. For the research vessel SpFB the number of stations and the number of resulting photographs are shown in the parentheses.

** The work of Menzies et al. presents an underwater photograph of this organism that is defined as Bryozoa Kinetoskias (Fig. 5-26, E), but Lemche et al. cite fairly convincing conclusions to support that in reality this is Branchiocerianthus sp.

***Level of catching by plankton net.

****As Pasternak notes [1970], Kophobelemnon from the KK trench in external appearance and in a number of other morphological signs differs drastically from the previously described K. biflorum from the northern Pacific Ocean and the Bering Sea from depths less than 4,000 m. However, Pasternak does not consider these differences to be taxonomically significant. I believe that the form taken from the KK trench is an independent species.

*****The photograph of Actinia taken from the KK trench as defined by F. A. Pasternak as G. hadale was published in the book Nauchno-issledovatelskoye sudno Vityaz' i ego ekspeditsii [Research Ship Vityaz and Its Expeditions], (1983, Table III, 7).

******Beliaev and Sokolova [1960a] indicate this species under the name G. aff. profundale. Individuals of this, undoubtedly new species were then found at the hadal depths of the Mariana trench at another 2 stations.

Таблица 4 (окончание)

1	2	3	4	5	6	7	8
			l Семейство ?				
36.	Paractis sp.	S A (Кайм (В) У (Кайм (О)	6800 6740–6780	"AK" (1) "AK" (1)			Келлер и др., 1975 4
37.	Antheomorphe sp.	Пал PL	8021–8042	"SpFB" (1–3ф) P			Lemche et al., 1976*
		НБ NB	7057–7075	"SpFB" (1–20ф)			
		Буг BG	7847–8662	"SpFB" (1–2ф) P			
			m Отряд Antipatharia				
38.	Bathypathes patula Brock	Ал AL	7200	"B" (1)	100	IN То, Ио, Ао	Пастернак, 1958, 8 1976
		КК	8175–8840	"B" (1)			
			m Отряд Madreporaria				
			l Семейство Fungiidae				
39.	Fungiacyathys symmetricus aleuticus Keller	Ал AL КК	6296–6328 6090–6135	"B" (1) "B" (1)	4620	h с То	Келлер, 1976 4
40.	F.s. fragilis Keller	I С-з котл То	6096	"B" (1)	2160	IN То, Ио	То же 3

*Определения по подводным фотографиям. Для э/с "SpFB" в скобках указано число станций и число полученных фотографий.

**В работе Мензиса с соавторами приведена подводная фотография этого организма, определенного как мшанка Kinetoskias (fig. 5–26, *E*), но Лемхе с соавторами приводят достадочно убедительные доводы в пользу того, что в действительности это Branchiocerianthus sp.

***Горизонт лова планктонной сетью.

****Как отмечает Пастернак [1970], Kophobelemnon из КК желоба по внешнему виду и ряду других морфологических признаков резко отличается от описанного ранее K. biflorum из северной части Тихого океана и Берингова моря с глубин менее 4000 м. Однако Пастернак не считает эти отличия таксономически значимыми. По моему мнению, форма из КК желоба представляет собой самостоятельный вид.

*****Фотография актинии из КК желоба, определенной Ф.А. Пастернаком как G. hadale, была опубликована в книге «Научно-исследовательское судно "Витязь" и его экспедиции» (1983, Табл. III, 7).

******Беляев и Соколова [1960а] указали этот вид под названием G. aff. profundale. В дальнейшем особи этого, несомненно нового, вида были найдены на наибольших глубинах Мар желоба еще на 2 станциях.

TABLE 5. POLYCHAETA

Key:
a. No. in order
b. Species
c. Finding deeper than 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at lowest depths
h. Minimum depth, m
i. Region of encounter
j. Source
l. Family
m. Order
o. Subclass

Column 8
1. Levenstein
2. Kucheruk

Таблица 5

Многощетинковые черви – Polychaeta

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	O Подкласс Errantia						
	M Отряд Eunicemorpha						
	l Семейство Dorvilleidae	AL					
1.	Ophryotrocha hadale Jumars	Ал	7298	"TW"(1)	–	–	Jumars, 1974
	l Семейство Lumbrineridae	SS				S	
2.	Lumbrineris abyssorum McIntosh	ЮС	6052–6150	"AK"(1)	4000	ю Ао, ю-в То S-e	Левенштейн, 1 1975
3.	Lumbrineris sp. n. Levenstein	AL Ал JAP Япон	6960–7250 6156–7587	"В"(2) "В"(5)	–	–	Левенштейн, 1 1973
4.	Paraninoe fusca (Moore)	Кер	6620–7000	"Gal"(3)	2770	e в То	Kirkegaard, 1956; Levenstein, 1977
5.	P. hartmani Levenstein	AL Ал JAP Япон КК	7250 6156–7587 6475–8100	"В"(1) "В"(4) "В"(5)	–	–	Левенштейн, 1 1973; Levenstein, 1977
	l Семейство Onuphiidae					IN	
6.	Onuphis ehlersi (McIntosh)	AL Ал КК	6296–6328 6090–6135	"В"(1) "В"(1)	3200	Ао, Ио, То, Ант	Кучерук, 2 1978, 1981
7.	Paraonuphis ultraabissalis Kucheruk	VOLC Волк Фил PLP	6330 6290–6330	"В"(1) "В"(1)	–	– ANT	Кучерук, 2 1977
	m Отряд Nereimorpha						
	l Семейство Hesionidae	B				IN Б	
8.	Ancistrosyllis constricta Southern	Бан	6580	"Gal"(1)	5	Ио – Бенгальский залив	Kirkegaard, 1956
9.	Hesionidae gen. sp.	BG Буг	8980–9043	"В"(1)			Левенштейн, 1 1969
	l Семейство Nephthyidae	IB				ANT	
10.	Micronephthys abranchiata (Ehlers)	ИБ Кер	8800–8830 8928–9174	"В"(1) "В"(1)	385	Ант	Левенштейн, 1 1962, 1973
11.	Nephthys elamelata Eliason	Кер	6180–7000	"Gal"(4)	4255	Ао	Kirkegaard, 1956
12.	Nephthyidae gen. sp.	BG Буг	8980–9043	"В"(1)			Левенштейн, 1 1969
	l Семейство Nereidae	JAP				n	
13.	Ceratocephale loveni Malmgren	Япон	6600–6670	"В"(1)	4400	с Ао, с То n	Левенштейн, 1 1973

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*The generic names in the Polynoidae family are given based on the new genera established by Pettibone in her work that covers the revision of the genus Macellicephala and the subfamily Macellicephalinae in the initial understanding of the volume of these taxons [Pettibone, 1976]. The changes in the volume of some species that were detected during a re-study of the materials from various habitats that were made in this work were also taken into consideration.

Key:

Column 7:
1. Yucatan trough
2. Slope
3. Japan and Okhotsk Seas
4. in the Atlantic Ocean , north Pacific Ocean (2 findings)

Column 8
3. Pasternak
4. Uschakov

Таблица 5 (окончание)

1	2	3	4	5	6	7	8
14.	Nereis profundi Kirkegaard	Бан B	7250–7290	”Gal”(1)	–	–	Kirkegaard, 1956
15.	N. caymanensis Fauchald	CAY Кайм (B)	5800–6850	”АК”(2)	4580	1 Юкатанская котл	Fauchald, 1977
16.	Nereis sp. sp.	PLP Фил	8080–8400	”В”(1)			Левенштейн, 1 1961a; Левенштейн, 1 Пастернак, 3 1976
		Яв Y	6935–7060	”В”(1)			
17.	Nereidae gen. sp.	JAP Япон	7565–7587	”В”(1)			Левенштейн, 1 1973
			m Отряд Phyllodocemorpha				
			l Семейство Aphroditidae				
18.	Laetmonice benthaliana McIntosh	SS ЮС	6766–6875	”АК”(1)	45	IN Ао, Ио, То	Левенштейн, 1 1975
			l Семейство Glyceridae				
19.	Bathyglycinde longisetosa Levenstein	SS ЮС	7218–7934	”АК”(2)	–	–	Левенштейн, 1 1975
			l Семейство Phyllodocidae				
20.	Eulalia sandvichiensis Ushakov	SS ЮС	6052–7218	”АК”(3)	5078	2 Склон ЮС	Ушаков, 1975 4
21.	E. sigeiformis Annenkova	AL Ал	7246	”В”(1)	443	3 Япон. и Охотское моря	Ушаков, 1972 4
22.	Vitiazia dogieli Uschakov	КК JAP	6150–8100	”В”(4)	–	–	Ушаков, 1953, 4 1972
		Япон	7190–7587	”В”(2)			
			l Семейство Polynoidae*				
23.	Bathyedithia berkeleyi Levenstein	Ал AL	6965–7000	”В”(1)	–	–	Левенштейн, 1 1971, 1978a; Levenstein, 1971
		Рюкю RYU	6810–7450	”В”(2)			
		Фил PLP	7420–7880	”В”(1)			
24.	Bathyeliasona abyssicola (Fauvel)	Ал AL	7286	”В”(1)	3830	h с Ао, h с То	Левенштейн, 1 1969, 1971; Pettibone, 1976
		Буг DG	6920–8006	”В”(2)			
25.	B. kirkegaardi (Uschakov)	Ал AL	6925–7250	”В”(4)	5275 и 5525	4 в Ао, с То (2 нахождения)	Ушаков, 1971, 4 1982; Kirkegaard, 1956; Левенштейн, 1 1971, 1973, 1978a; Pettibone, 1976
		ИБ IB	6770–6890	”В”(1)			
		VOLC Волк	6330	”В”(1)			
		Пал P	7000–7170	”В”(1)			
		Фил PLP	7420–7880	”В”(1)			
		Рюкю RYU	7440–7450	”В”(1)			
		Кер	6620–7000	”Gal”(3)			
		Бан B	7250–7290	”Gal”(1)			
		Яв Y	7130–7160	”Gal”(1)			

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*Родовые названия в семействе Polynoidae даны с учетом новых родов, установленных Петтибон в ее работе, посвященной ревизии рода Macellicephala и подсемейства Macellicephalinae в первоначальном понимании объема этих таксонов [Pettibone, 1976]. Учтены также и проведенные в этой работе изменения объема некоторых видов, выявленные при переисследовании материалов из разных местообитаний.

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Таблица 5 (продолжение)

1	2	3	4	5	6	7	8
26.	Bathykermadeca hadalis (Kirkegaard)	Кер Яп YAP Япон JAP Бан B Фил? PLP	6660–8300 8560–8720 7350–7370 7250–7290 10160–10210	"Gal"(3) "B"(1) "B"(1) "Gal"(1) "Gal"(2)	–	–	Kirkegaard, 1956; Pettibone, 1976; Левенштейн, 1978a, 1982 /
27.	Bathykurila zenkevitchi (Uschakov)	КК JAP Япон Фил PLP	8100–8135 6600–6670 8080–8400	"B"(2) "B"(1) "B"(1)	–	–	Ушаков, 1955, 4 1982; Левенштейн, / 1971; Левенштейн, / Пастернак, 3 1976
28.	Bathylevensteinia bicornis (Levenstein)	Тон TON	9735–9875	"B"(1)	–	–	Левенштейн, / 1962; Pettibone, 1976
29.	Bathymariana zebra Levenstein	Рюкю RYU	7440–7450	"B"(1)	–	–	Левенштейн, / 1978a
30.	Bathymoorea aff. renotubulata (Moore)	ЮС SS	6052–6150	"AK"(1)	–	–	Левенштейн, / 1975
31.	Macellicephala alia Levenstein	Пал P	7970–8035	"B"(1)	–	–	Левенштейн, / 1978a
32.	M. mirabilis McIntosh (?)	ПР PR	7625–7900	"A-2"(1)	–	–	Eliason, 1951
33.	M. tricornis Levenstein	ЮС SS	7200–8116	"AK"(3)	–	–	Левенштейн, / 1975
34.	M. violacea (Levinsen)	Ал AL КК JAP Япон	7250 6135–9530 7370	"B"(1) "B"(4) "B"(1)	46	n с Ао, n с То, Аркт Arc	Ушаков, 1955, 4 1982; Левенштейн, / 1971, 1973, 1982
35.	Macellicephaloides grandicirra Uschakov	КК	8100–9500	"B"(4)	–	–	4 Ушаков, 1955; Левенштейн, 1971 /
36.	M. improvisa Levenstein	КК	8035–8120	"B"(1)	–	–	Левенштейн, / 1983
37.	M. sandvichiensis Levenstein	ЮС SS	7200–7934	"AK"(2)	–	–	Левенштейн, / 1975
38.	M. uschakovi Levenstein	КК	8035–8120	"B"(1)	–	–	Левенштейн, / 1971
39.	M. verrucosa Uschakov	КК JAP Япон	7210–8015 6156–6207	"B"(2) "B"(1)	–	–	Ушаков, 1955; 4 Левенштейн, / 1961б, 1971
40.	M. villosa Levenstein	Япон JAP	7350–7370	"B"(1)	–	–	Левенштейн, / 1982
41.	M. vitiazi Uschakov	КК	7210–8430	"B"(4)	–	–	Ушаков, 1955; 4 Левенштейн, / 1971
42.	Macellicephaloides sp. (видимо, новый вид) APPARENTLY A NEW SPECIES	Мар M	7990–10710	"B"(2)	–	–	Левенштейн, / 1962

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**P--stereoscopic underwater floor photographs.

Key:
Column 2.
2. (different species known either from fragments or from underwater photographs; sometimes indicated under different genera or tentative species names)

Column 8
5. and personal report
6. Kucheruk

Таблица 5 (продолжение)

1	2	3	4	5	6	7	8
43.	Polynoidae sp. sp. (разные 2 виды, известные или по фрагментам, или по подводным фотографиям; иногда указаны под разными родовыми или предположительными видовыми названиями)	КК JAP	8175–9335	"B" (3)			Левенштейн, 1 1961а, 1962, 1973, 1978а, 1982 и личное сообщение; 5 Lemche et al., 1976
		Япон	6475–7370	"B" (2)			
		ИБ IB	6770–9735	"B" (2)			
		Волк VOLC	6780–6785	"B" (1)			
		Мар M	10170–10730	"B" (3)			
		Пал P	8021–8042	"SpFB" (1) ф** P			
		Фил FLP	7610–9990	"B" (4)			
		НБ NB	7875–8260	"SpFB" (2) ф P			
		Буг BG	7847–8662	"SpFB" (1) ф			
		НГ NH	6758–8930	"SpFB" (2) ф			
		TON Тон	10415–10687	"B" (1)			
		Яв Y	6820–6850	"B" (1)			
	m Семейство Sigalionidae						
44.	Leonira quatrefagesi Kinberg	SS ЮС	6050–6150	"АК" (1)	4	SW ю-з Ао	Левенштейн, 1 1975
	a Подкласс Sedentaria						
	m Отряд Drilomorpha						
	l Семейство Capitellidae				6	IN	
45.	Notomastus latericeus Sars	Хьорт	6200–6230	DM "ДМ" (1)	Сублитораль	Ао, Ио, То	Левенштейн, 1 1978б
46.	N. latericeus Sars (?)	ЮС SS	6875–7216	"АК" (2)	5078	Район ЮС 7	Левенштейн, 1 1975
47.	Notomastus sp. sp.	Ал AL	6550	"B" (1)			Kirkegaard, 1956; Левенштайн, 1 1973, 1975, 1978б; Ушаков, 4 личное сообщение 5
		КК JAP	6860–8660	"B" (3)			
		Япон	6600–7587	"B" (3)			
		Кер	8210–8300	"Gal" (1)			
		Яв Y	6820–6850	"B" (1)			
48.	Capitellidae sp. sp.	Ал AL	6410–7246	"B" (2)			Левенштейн, 1 1961б, 1973
		JAP Япон	7190	"B" (1)			
	l Семейство Fauveliopsidae						
49.	Fauveliopsis brevis (Hartman)	КК	6835	"B" (1)	1200	Ао, То	Левенштейн, 1 1970б, 1975; Кучерук, 1981 6
		Пер P	6200–6240	"АК" (1)			
		ЮС SS	6052–6150	"АК" (1)			
50.	F. challengerie McIntosh	КК 1	6090–6135	"B" (1)	1000	Ао, То, Ант ANT	Левенштейн, 1 1970б; Кучерук, 6 1981
		С-в котл То	6065–6282	"B" (2)			
	l Семейство Flabelligeridae						
51.	Brada irenaia Chamb.	КК	6860	"B" (1)	1580	То	Левенштейн, 1 1969
52.	Brada sp.	ЮС SS	6052–7934	"АК" (4)	4720	Район 7 ЮС	Левенштейн, 1 1975
53.	Ilyphagus bythincola Chamberlin	Яв Y	6730–6850	"Gal" (1)	3436	e в То	Kiekegaard, 1956
54.	I. wyvillei (McIntosh)	SC м Скотия	5650–6070	"АК" (1)	3330	IN Ао, Ио, То	Левенштейн, 1 1975

**Ф – стереоскопические подводные фотографии дна.

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Key:
Column 8
7. Detinova
8. Vinogradova

Таблица 5 (продолжение)

1	2	3	4	5	6	7	8
55.	Flabelligeridae sp. n.	Ал AL Япон JAP	6965–7000 6600–7587	"В"(1) "В"(2)	–	–	Левенштейн, 1 1973
			l Семейство	Maldanidae			
56.	Maldanella harai (Izuka)	Кер	6620–6720	"Gal"(2)	100	IN Ао, Ио, То	Kirkegaard, 1956
57.	M. japonica Detinova	JAP Япон 2 С-з котл То 1 С-в котл То 2	6156–6840 6096 6272–6282	"В"(2) "В"(1) "В"(1)	5027	с То n	Детинова, 1982 7
58.	Notoproctus oculatus Arwidson	С-з котл То	6096	"В"(1)	70	Ао, То	Левенштейн, 1 1969
59.	N. o. antarcticus Arwidson	ЮС SS	6766–6875	"АК"(1)	218	ANT Ант	Левенштейн, 1 1975
60.	Notoproctus sp.	JAP Япон	6156–6207	"В"(1)			Левенштейн, 1 1961б, 1973
61.	Petalóproctus cirratus (Monro) (?)	Бан B	7250–7290	"Gal"(2)	–	–	Kirkegaard, 1956
62.	Maldanidae sp. sp.	КК JAP Япон	6860–7230 6380	"В"(2) "В"(1)			Левенштейн, 1 1973; Ушаков, 4 личное сообщ. 5
			l Семейство	Opheliidae			
63.	Ammotrypane galatheae Kirkegaard	Бан B	7250–7290	"Gal"(1)	–	–	Kirkegaard, 1956
64.	Ammotrypane sp. sp.	Ал AL JAP Япон Буг BG	7250 7370–7587 8980–9043	"В"(1) "В"(2) "В"(1)			Левенштейн, 1 1969, 1973
65.	Kesun abyssorum Monro	Ал AL КК JAP Япон ИБ IB 2 С-з котл То 1 С-в котл То Фил PLP Буг BG Кер Яв Y Ром R ЮС SS SC м Скотия	6960–7250 6080–8430 6156–7370 8800–9735 6076–6096 6065 8080–8400 6920–8006 6960–8300 6740–6850 6330–7600 6052–8116 5650–6070	"В"(5) "В"(13) "В"(3) "В"(2) "В"(2) "В"(1) "В"(1) "В"(2) "Gal"(2) "Gal"(1) "В"(2) "АК"(3) "АК"(5) "АК"(1)	193	IN Ао, Ио, То, Ант ANT	Левенштейн, 1 1961а, 1970а, 1973, 1975; Виноградова, 1974; 8 1 Левенштейн, Пастернак, 1976 3
66.	K. fuscus Chamberlin	Япон JAP	7565–7587	"В"(1)	3000	То	Левенштейн, 1 1970а, 1973
67.	Travisia profundi Chamberlin	Ал AL КК JAP Япон Бан B	7250 6090–7230 6156–7190 6490–7290	"В"(1) "В"(7) "В"(3) "Gal"(3)	975	Ао, То, Ант ANT	Kirkegaard, 1956; Левенштейн, 1 1970а, 1973

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Key:
Column 6/7
8. Single finding
9. Bering Sea

Column 8
9. The same

Таблица 5 (продолжение)

1	2	3	4	5	6	7	8
68.	Travisia sp.	JAP Япон	7460–7557	”HM”(2)			Shin, 1984
	l Семейство Oweniidae						
69.	Myriochele sp.	Кер	6180–8300	”Gal”(3)			Kirkegaard, 1956
70.	Owenia lobopygidiata Uschakov (?!)	Бан B	6490–6650	”Gal”(2)	–	–	Kirkegaard, 1956
71.	Oweniidae sp. sp.	Ал AL	6296–7246	”B”(3)			Левенштейн, 1 1973; Ушаков, 4 личное сообщение 5
	l Семейство Scalibregmidae						
72.	Pseudoscalibregma pallens Levenstein	Кер	8928–9174	”B”(1)	–	–	Левенштейн, 1 1962
73.	P. collaris Levenstein	SC м Скотия	5650–6070	”AK”(1)	8 Единственное нахождение		Левенштейн, 1 1975
74.	Scalibregmidae sp. sp.	JAP Япон КК	6600–6700 6860	”B”(1) ”B”(1)			Левенштейн, 1 1973; Ушаков, 4 личное сообщение 5
	m Отряд Serpulimorpha						
	l Семейство Sabellidae						
75.	Potamethus filatovae (Levenstein)	Ал AL КК JAP Япон ИБ IB	6328–6960 7210–7230 6380–6700 9715–9735	”B”(4) ”B”(1) ”B”(3) ”B”(1)	3812	9 Берингово м	Левенштейн, 1 1961в, 1969, 1973 и личное сообщение 5; Левенштейн, 1 1973 и личное сообщение 5
76.	Potamethus sp. sp.	Япон JAP ИБ IB Кер Бан B	6156–6380 8530–8735 6620–8300 7280	”B”(2) ”B”(2) ”Gal”(2) ”Gal”(1)			(Kirkegaard, 1956 – Jasmineira sp.)
77.	Potamilla sp.	КК	8100	”B”(1)			4 Ушаков, личное сообщение 5
78.	Sabellidae sp. sp.	КК Пал P НГ NH	7210–7230 8021–8042 6758–6776	”B”(1) ”SpFB” (1) ф ”SpFB” (1) ф			1 Левенштейн, 1969; Lemche et al., 1976
	l Семейство Serpulidae						
79.	Serpulidae sp. sp.	Ал AL ИБ IB Кер	6410–6757 9715–9735 6620	”B”(1) ”B”(1) ”Gal”(1)			Kirkegaard, 1956; 1 Левенштейн, 1973
	m Отряд Spiomorpha						
	l Семейство Chaetopteridae						
80.	Phyllochaetopterus sp.	КК	6860	”B”(1)			4 Ушаков, личное сообщение 5
	l Семейство Cirratulidae						
81.	Chaetozone sp.	Яв Y	6935–7060	”B”(1)			1 Левенштейн, 1961а
82.	Cossura longicirrata Webster et Benedict	Яв	6487	”B”(1)	11	Ao, To	9 То же

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Key:

Column 8

10. Safronova

Таблица 5 (окончание)

1	2	3	4	5	6	7	8
83.	Tharix multifillus Moore	Бан B	6580	"Gal"(1)	1	IN Ио, То	Kirkegaard, 1956
84.	Tharix sp. sp.	Яв Y ЮС SS	6820–6850 7200–8116	"В"(2) "АК"(2)			Левенштейн, 1 1961а, 1975
85.	Cirratulidae sp. sp.	Ал AL Кер	7246 8928–10015	"В"(1) "В"(1)			Левенштейн, 1 1962, 1973
		TON	l Семейство Disomidae				
86.	Poecilochaetus vitjazi Levenstein	Тон	10415–10687	"В"(1)	–	–	Левенштейн, 1 1962
			m Отряд Terebellomorpha				
		P	l Семейство Ampharetidae				
87.	Amagopsis cirratus Kucheruk	Пер	6200–6240	"АК"(1)	4820	e в То, 11 м Банда	Кучерук, 1976 2
88.	Amphicteis gunneri antarctica Hessle	SS ЮС	7686	"Elt"(1)	267	S ю Ао	Hartman, 1967а
89.	A. g. japonica McIntosh	AL Ал КК JAP Япон	6965–7250 6475–6571 6156–7587	"В"(2) "В"(1) "В"(2)	12	n с То	Левенштейн, 1 1969, 1973
90.	A. mederi Annenkova	КК JAP Япон	7210–8430 6380	"В"(3) "В"(1)	88	nw с-з То	Ушаков, 4 1952 и личное сообщение 5; Левенштейн, 1 1973
91.	Anobothrus sp.	КК JAP Япон	6860 6156–6207	"В"(1) "В"(1)			1 Левенштейн, 1973; 4 Ушаков, личное сообщение 5
92.	Mellinampharete eoa Annenkova	КК	6150–6860	"В"(2)	78	n с То	Левенштейн, 1 1969; Ушаков, 4 личное сообщение 5
93.	Ampharetidae sp. sp.	AL Ал КК JAP Япон Кер Яв Y	6296 7210–7230 6156–6207 6660–6720 6820–7000	"В"(1) "В"(1) "В"(1) "Gal"(1) "Gal"(1) "В"(1)			Kirkegaard, 1956; 1 Левенштейн, 1961а, 1969, 1973; Ушаков, 4 личное сообщение 5
			l Семейство Terebellidae				
94.	Pista mirabilis McIntosh	КК JAP Япон 2 С-з котл То Пер P	6205–6215 6156–6207 6096 6040–6240	"В"(1) "В"(1) "В"(1) "АК"(2)	100	Ао, То, Ант ANT	10 Сафронова, 1984, личное сообщение 5
95.	Pista sp.	Ал AL Япон JAP	6296–6328 6156–6207	"В"(1) "В"(1)			Левенштейн, 1973 1
		l	Семейство Trichobranchiidae				
96.	Terebellides eurystethus Chemberlin	Ал AL КК JAP Япон Кер	6960 7210–7230 7190–7587 6660–6770	"В"(1) "В"(1) "В"(3) "Gal"(1)	1410	e в То	Kirkegaard, 1956; Левенштейн, 1973; 1 4 Ушаков, личное сообщение 5
97.	T. stroemi kerguelensis McIntosh	Хьорт Hjort	6100–6210	"ДМ"(1) DM	10 Батиаль	12 Ант и Суб-ант	Левенштейн, 1 1978б

TABLE 6. ECHIURA

Таблица 6

Эхиуриды – Echiura

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
1	2	3	4	5	6	7	8
			l Семейство Bonelliidae				
1.	Alomasoma chaetifera Zenkevitch	Ал AL С-в 1 котл То	7246 6065	”В” (1) ”В” (1)	2415	То	Зенкевич, 1958; 1 Зенкевич, Мурина, 1976 2
2.	A. nordpacifica Zenkevitch	Ал AL КК Волк VOLC	7246 6090–8430 7584–7614	”В” (1) ”В” (5) ”В” (1)	520	h с То, h с Ао	То же и Datta, Gupta, 1981 3
3.	Bruunellia bandae Zenkevitch	Бан B	7250–7290	”Gal” (1)	2906	h с Ао	Zenkevitch, 1966; Datta, Gupta, 1981
4.	Hamingia arctica Dan. et Koren	Пал PL Рюкю RYU	7970–8035 7440–7450	”В” (1) ”В” (1)	65	ARC, ANT Арк, Ант	Беляев, Миронов, 1977a; 4 Мурина, 1978* 9
5.	Ikedella bogorovi Zenkevitch	Яв Y	6820–6850	”В” (1)	–	–	Зенкевич, 1964 1
6.	Jakobia birsteini Zenkevitch	КК Япон JAP ЮС SS ?Ром R	6475–9730 6600–7370 7200–7216 7460–7600	”В” (6) ”В” (2) ”АК” (1) ”АК” (1)	5030	REGION Район КК	Зенкевич, 1958; 1 Виноградова, 1974; 5 Виноградова и др., 1974; 5 Зенкевич, Мурина, 1976 2
7.	Kurchatovus tridentatus Datta Gupta	ПР PR Кайм (О) CA	5890–6000 6740–6780	”АК” (1) ”АК” (1)	4580	I Юкатанская котл	Wolff, 1976b, 1979; Datta, Gupta, 1977
8.	Pseudoikedella sp.	Фил PL	9980–9990	”В” (1)			Беляев, Миронов, 4 1977a; Мурина, 9 1978a
9.	Sluiterina flabellorhynchus Murina	SC м Скотия ПР PR	5650–6070 6400	”АК” (1) ”АК” (1)	4664	SC м Скотия, ц Ао C	Виноградова и др., 5 1974; Мурина, 6 1978a и личное сообщение 7
10.	S. vitjazi Murina	Ал AL	6965–7000	”В” (1)	–	–	Мурина, 1978a 6
11.	Torbenwolffia galatheae Zenkevitch	Ал AL Кер Яп JAP	6965–7000 6660–8300 8560–8720	”В” (1) ”Gal” (3) ”В” (1)	3850 5880	w з То, Ао (котл 2 Зел/М)	Wolff, 1960; Zenkevitch, 1966; Зенкевич, Мурина, 1976; 2 Беляев, Миронов, 4 1977a; Мурина, 6 1978a*; Datta, Gupta, 1981
12.	Vitjazema aleutica Zenkevitch	Ал AL	7246–7286	”В” (2)	–	–	Зенкевич, 1958a 1
13.	V. planirostris Murina	Фил PLP	9750	”В” (1)	–	–	Беляев, Миронов, 4 1977a; Мурина, 6 1978a

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Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source

Column 3
1. Northeast trough

Column 7
1. Yucatan trough
2. (trough) ZM

Column 8

1. Zenkevitch
2. Zenkevitch, Murina
3. The same
4. Beliaev, Mironov
5. Viinogradova
6. Murina
7. and personal report
8. Zenkevitch, Filatova
9. Murina

Additionally, Echiura that have not been defined more precisely were found in the trenches: Al, 6,965-7,000 m, B, st. 6085; Jap 6,700-7,540 m, RM st. E2 and B st. 7500, 7503; IB 7,305-8540 m, B st. 3491 and 3514; BG 7,974-8,006 m, B st. 3663, 8 specimens juv.; in the ZM trough, 6,035 m, PrAl st. 1173 [per: Sluter, 1912; Suyehiro et al., 1972; Beliaev, 1966b, 1972; Zenkevitch, Murina, 1976].

It is quite likely that in the Aleutian trench, in addition to the 5 species indicated in the table, there are another 2 genera of Protobonella that were found somewhat to the south of this trench at depths over 5.5 km: P. nikitini Murina at depth 5,681-5740 m and P. zenkevitchi Murina at depth 5,595-5,660 m [Murina, 1976].

*The indication by Murina [1978a] of finding three species of Echiuria in the Mariana trench is inaccurate. In reality, the species of the genus Hamingia was found in the Palau trench, and Torbenwolffia galatheae and Vitjazema ultraabyssalis in the Yap trench. Additionally, a representative of the genus Vitjazema not defined to species level was found in the Philippine trench and not V. ultraabyssalis.

Таблица 6 (окончание)

1	2	3	4	5	6	7	8
14.	V. ultraabyssalis Zenkevitch	КК ИБ IB Яп YAP	7210–9530 9715–9735 7190–7250	"В" (8) "В" (1) "В" (1)	3880	IN То, Ио	Зенкевич, 1958; 1 Зенкевич, Мурина, 2 1976; Беляев, Миронов, 1977a; 4 Мурина, 1978a* 6
15.	Vitjazema sp. sp.	Фил PLP Фил PLP Пер P	8080–8400 10150–10210 6200–6240	"В" (1) "Gal"(1) "АК" (1)			Bruun, 1953, 1956b; Zenkevitch, 1966; Зенкевич, Филатова, 1971 8

Кроме того, не определенные точнее эхиуриды найдены в желобах: Ал, 6965–7000 м, "В", ст. 6085; Япон, 6700–7540 м, "RM", ст. Е-2 и "В", ст. 7500, 7503; ИБ, 7305–8540 м, "В", ст. 3491 и 3514; Буг, 7974–8006 м, "В", ст. 3663, 8 экз. juv.; в котл Зел М, 6035 м, "PrAl", ст. 1173 [по: Sluiter, 1912; Suyehiro et al., 1962; Беляев, 1966б, 1972; Зенкевич, Мурина, 1976].

Весьма вероятно, что в Алеутском желобе обитают, кроме 5 видов, указанных в таблице, еще 2 вида рода Protobonellia, найденные несколько южнее этого желоба на глубинах более 5,5 км: P. nikitini Murina – на глубине 5681–5740 м и P. zenkevitchi Murina – на глубине 5595–5660 м [Мурина, 1976]

***Указание Муриной [1978a] на нахождение трех видов эхиурид в Марианском желобе неточно. В действительности вид рода Hamingia найден в желобе Палау, а Torbenwolffia galatheae и Vitjazema ultraabyssalis – в желобе Яп. Кроме того, в Филиппинском желобе найден не V. ultraabyssalis, а представитель рода Vitjazema, не определенный до вида.**

Таблица 7

Пелагические веслоногие ракообразные – Copepoda Calanoida, известные с глубин более 6000 м (по сборам "Витязя", проведенным планктонными сетями* в Курило-Камчатском желобе и в одном случае в Бугенвильском желобе)

№ п/п a	Вид b	Ловы в горизонтах, охватывающих глубины более 6000 м (в скобках – число экз.) c	Распространение на глубинах менее 6000 м d		Источник g
			минимальная глубина лова, м e	район встречаемости f	
1	2	3	4	5	6
		h Семейство Aetideidae			
1.	Aetideus sp.**	8500–6000(1)	– i	–	Бродский, 1955 1
2.	Batheuchaeta anomala Markhaseva	7100–3860(6) 6912–960(1) 6540–3250(1) 7040–3000(2) 6240– ?(1)	4000 (7 ловов – минимальная начальная глубина лова 4032 м)	КК	Мархасева, 1981, 1986a
3.	B. gurjanovae (Brodsky)	8500–6000(13) 7100–3860 (8) 8100–1200 (1) 7084–5880 (1) 7040–3000 (7) 7200–5785 (1) 6785–4035 (3) 6854–5952 (2) 6138–5022 (4) 6210–5130 (2) 6240– ? (4) 6246–0 (7)	j 4000 (5 ловов – минимальная начальная глубина лова 4000 м)	КК	Бродский, 1955; 1 Мархасева, 1986a

TABLE 7. PELAGIC COPEPODA CALANOIDA KNOWN FROM DEPTHS OVER 6,000 m (from Vityaz collections made by plankton nets* in the Kuril-Kamchatka trench and in one case in the Bougainville trench)

Key:
a. No. in order
b. Species
c. Catches in levels that cover depths over 6,000 m (number of specimens is in the parentheses)
d. Dissemination at depths less than 6,000 m
e. Minimum depth of catch, m
f. Region of encounter
g. Source
h. Family
i. 4,000 (7 catches, minimum initial depth of catch 4,032 m)
j. 4,000 (5 catches, minimum initial depth of catch 4,000 m)

Column 6
1. Brodsky, Markhaseva

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Key:
Column 4
k. 4000 (4 catches, minimum initial depth of catch 4,000 m)
l. about 4,500 (2 catches: 4,969-4,045 and 5,200-4,170)
m. surface
n. about 4,500 (5 catches, minimum depth of catch 4,730)
o. about 4,000 (2 catches: 4,950-3,940 and 5,950-2,830)
p. 2,000 (7 catches, of them, only 1 at 2,00-1,500, the others no less than from 3,600 m)

Column 6
1. Markhaseva
3. Brodsky
4. The same
5. Heptner

Таблица 7 (продолжение)

1	2	3	4	5	6
4.	B. heptneri Markhaseva	7100–3860 (1)	k 4000 (4 лова – минимальная начальная глубина лова 4000 м)	КК	2 Мархасева, 1981, 1986а
5.	B. peculiaris Markhaseva	6540–3250 (1) 6240– ? (1)	Около 4500 l (2 лова: 4969–4045 и 5200–4170)	КК	2 Мархасева, 1983, 1986а
6.	B. tuberculata Markhaseva	7040–3000 (1)	–	–	Мархасева, 1986а 2
7.	Pseudeuchaeta spinata Markhaseva	6210–5130 (1)	–	–	Мархасева, 1986б 2
8.	Pseudeuchaeta sp.**	8500–6000 (1)	–	–	Бродский, 1955 3
	h Семейство Bathypontiidae ?				
9.	Zenkevitchiella abyssalis Brodsky	8500–6000 (1)	–	–	То же 4
	h Семейство Calanidae				
10.	Calanus tonsus Brady	8500–6000 (1)	Поверхность n	n с То, Ант ANT	”
	h Семейство Euchaetidae				
11.	Pareuchaeta plicata Heptner	7100–3860 (2) 6900–3600 (2) 7390–1440 (2)	n Около 4500 (5 ловов – минимальная начальная глубина лова 4730)	КК	Гептнер, 1986 5
12.	Pareuchaeta sp.	8500–6000 (2)			Бродский, 1955 3
	h Семейство Heterorhabdidae				
13.	Heterorhabdus compactus (Sars)	8500–6000 (2) 6920–5850 (1) 6850–5960 (1)	100	ALL Все океаны OCEANS	Бродский, 1955, 3 Гептнер, 1971, 5 1973
	h Семейство Lucicutiidae				
14.	Lucicutia anomala Brodsky	6850–5950 (1) 6900–3600 (3) 6930–4110 (1) 6140–5020 (2) 6210–5130 (1)	2000	ARCT. Аркт, h с Ао, n с То	5 Гептнер, 1971, 1973, 1986
15.	L. biuncata Heptner	6900–3600 (1)	3900–1900	КК	5 Гептнер, 1971, 1986
16.	L. cinerea Heptner	7100–3860 (1)	3860–3470	КК	То же 4
17.	L. curvifurcata Heptner	7100–3860 (1) 7100–3860 (1) 7700–1500 (1) 8150–0 (3) – лов в Буг	o Около 4000 (2 лова: 4950–3940 и 5950–2830)	КК	”
18.	L. ushakovi Brodsky	7390–1140 (2) 8500–6000 (1) 6990–6000 (2) 6850–5950 (6) 7100–3860 (1) 6930–4110 (3) 6210–5130 (3) 6140–5020 (4)	p 2000 (7 ловов, из них лишь 1 – 2000–1500, остальные не менее, чем с 3600 м)	КК	3 Бродский, 1955, Гептнер, 1971, 5 1973, 1986

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Key:

Column 4
q. 4,000 (2 catches: 5,090-4,050 and 4,830-3,100 m)
r. from 1,000 to 3,000

Column 7
6. Vyshkvartzeva

Additionally, 15 species (Batheuchaeta lamellata Brodsky, 5 species of Pareuchaeta, 2 species of Valdiviella and 7 species fo Lucicutia, see: [Heptner, 1986; Markhaseva, 1986a]) were found in one or several catches made in the levels covering depths from ultra-abyssal to abyssal or bathyal, but the same species in even more numerous catches are known from depths less than 6,000 m. It is therefore more likely that in the catches taken in the ultra-abyssal depths, these Copepoda were caught at lower depths.

* The two indicated depths (e.g., 8,500-6,000) designate the boundaries of the level seined by closing nets.

** It follows from the remarks of K. A. Brodsky [1955] that the species noted by two asterisks are apparently new.

Таблица 7 (окончание)

1	2	3	4	5	7
19.	Lucicutia sp. "aurita ?"	6140–5020 (1)	9 4000 (2 лова: 5090–4050 и 4830–3100 м)	КК	5 Гептнер, 1986
		h Семейство Metridiidae	4		
20.	Metridia ochotensis Brodsky	8500–6000 (1)	50	^ с То	3 Бродский, 1955
21.	M. similis abyssalis Brodsky	8500–6000 (37)	–	–	То же 4
		h Семейство Phaennidae			
22.	Xanthocalanus pavlovskii Brodsky	8500–6000 (2)	–	–	"
		h Семейство Spinocalanidae			
23.	Mimocalanus distinctocephalus Brodsky	8500–6000 (1)	1000	nw с-з То	"
24.	Spinocalanus similis profundalis Brodsky	8500–6000 (64)	–	–	"
		h Семейство Scolocithricidae			
25.	Parascaphocalanus zenkevitchi Brodsky	8500–6000 (97)	–	–	3 Бродский, 1955
26.	Puchinia obtusa Vyshkvartzeva (= Scolecithricidae gen. sp., копеподит – IV**)	8000–6500 (1)	–	–	Вышкварцева, 6 1989; Бродский, 3 1955
27.	Scaphocalanus acutocornis Vyshkvartzeva	6551–4295 (1)	–	–	6 Вышкварцева, 1987
28.	S. bogorovi Brodsky	8500–6000 (1)	r От 1000 до 3000	IN Ао, Ио	3 Бродский, 1955; Grice, Hulsemann, 1965, 1967
29.	Scaphocalanus sp.**	8500–6000 (1)	–	–	Бродский, 1955 3
30.	Scolecithrix birsteini f. major Brodsky	8500–6000 (1)	–	–	То же 4
31.	S. birsteini f. minor Brodsky	8500–6000 (1)	–	–	"
32.	Scolecithricidae gen. sp.**	8500–6000 (1)	–	–	"

Кроме того, 15 видов (Batheuchaeta lamellata Brodsky, 5 видов Pareuchaeta, 2 вида Valdiviella и 7 видов Lucicutia – см.: [Гептнер, 1986; Мархасева, 1986а]) встречены в одном или нескольких ловах, проведенных в горизонтах, охватывающих глубины от ультраабиссали до абиссали или батиали, но те же виды и по более многочисленным уловам известны с глубин менее 6000 м. Поэтому наиболее вероятно, что при ловах, охватывающих и ультраабиссальные глубины, рачки этих видов были пойманы на меньших глубинах.

*Две указанные глубины (напр., 8500–6000) обозначают границы горизонта, обловленного замыкающимися сетями.

**Из замечаний К.А. Бродского [1955] следует, что виды, отмеченные двумя звездочками, по-видимому, новые.

TABLE 8. CIRRIPEDIA

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Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shalower depths
h. Minimum depth, m
i. Region of encounter
j. Source
l. Family

Column d
1. Northwest trough

Column j
1. Zevina
2. Tarasov, Zevina
3. The same

TABLE 9. OSTRACODA

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, h
i. Region of encounter
j. Source
k. Benthic
l. Family

Column 8
1. Beliaev (Rudjakov)
2. Beliaev, Mironov
3. The same
4. Schornikov

Таблица 8

Усоногие ракообразные – Cirripedia

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
	l Семейство Scalpellidae						
1.	Amigdoscalpellum vitreum (Hoek)	I С-з котл То	6096	"В"(1)	818	IN Ао, Ио, То, Ант ANT	Зевина, 1970, 1977, 1981 1
2.	Annandaleum japonicum (Hoek)	КК JAP Япон Рюкю RYU С-з котл I То	6675–6860 6156–6380 6810 6096	"В"(2) "В"(2) "В"(1) "В"(1)	805	То, Ио IN	Тарасов, Зевина, 1957; Зевина, 1977, 1981 2 1
3.	Meroscalpellum ultraabyssicolum (Zevina)	RYU Рюкю	6660–6670	"В"(1)	–	–	Зевина, 1977, 1981 1
4.	Neoscalpellum eltaninae Newman et Ross (= Scalpellum profundale Zevina)	Пер P	6040	"АК"(1)	5020	PERU у Перу	Zevina, 1972; Зевина, 1981, 1982 1
5.	Planoscalpellum hexagonum (Hoek)	Пер P	6040	"АК"(1)	2798	То	Zevina, 1972; Зевина, 1981 1
6.	Trianguloscalpellum regium (W. Thomson)	КК	6090–6135	"В"(1)	1507	IN Ао, Ио, То	Зевина, 1970, 1981 1
7.	Weltnerium speculum (Zevina)	SC м Скотия	5650–6070	"АК"(1)	4664	ю Ао S	Зевина, 1975, 1981 1
8.	Arcoscalpellinae sp. 1 juv. Zevina	ИБ IB	6770–6850	"В"(1)			Зевина, 1977 1
9.	Arcoscalpellinae sp. 2 juv. Zevina	Фил FLP	7420–7880	"В"(1)			То же 3
10.	Scalpellum sp.	Кер	6620–7000	"Gal"(3)			Bruun, 1955; Wolff, 1960

Таблица 9

Ракушковые ракообразные – Ostracoda

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
1	2	3	4	5	6	7	8
	K Донные*						
	l Семейство Bairdiidae						
1.	Bairdiidae sp. n. Rudjakov	BG Буг	6920–7657	"В"(1)	–	–	Беляев, 1966б (Рудяков) 1
2.	Bairdia sp.	PL Пал	7000–7170	"В"(1)			Беляев, Миронов, 1977а (Шорников) 2 4
	l Семейство Bythocyprididae						
3.	Bythocypris sp.	Фил PLP	6290–6330	"В"(1)		IN	То же 3
4.	Retibythere (Bathybythere) scaberrima (Brady)	ПР PR	7950–8100	"АК"(1)	481	Ао, Ио, То	Шорников, 1987 4

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Key:
Column 3
1. Northwest trough

Column 8
2. Beliaev, Mironov
4. Schornikov
5. Rudjakov

Additionally, from the Kermadec trench (Gal, st. 654) a new genus of benthic Ostracoda Hadacypridina and species H. bruuni Poulsen were described [Poulsen, 1962]. The initial description indicated the depth of its finding as 6,000 m. But according to the refined list of stations of the Galathea expedition [Bruun, 1958], the depth of this catch was lower, 5,850-5,900 m. It is quite likely, however, that this species dwells in the Kermadec trench even below 6,000 m. Three specimens of Ostracoda not defined more closely were found in a bottom drag sample from the Aleutian trench from depth 7,298 m [Jumars, Hessler, 1976].

Column 4
m. Pelagic
n. and the same catches as for No. 12

Column 7
n. (regions of trenches KK, M, Kep)

Column 8
6. Chavtur

*Depths of catches are given by bottom grab or benthic trawl.
**Levels of catches by plankton nets are given.
***Pacific Ocean forms possibly belong to a special subspecies [Rudjakov, 1962].

Таблица 9 (окончание)

1	2	3	4	5	6	7	8
5.	Zabythocypris chinukensis Schornikov	С-в котл 1 То	6065	"В"(1)	–	–	Шорников, 1980 4
6.	Z. helicina Maddocks	Пер P	5986–6134	"АВ"(1)	1335	IN в То, Ао (Мексиканский залив) GULF OF MEXICO	Maddocks, 1969
	l Семейство Cytheridae						
7.	Krithe setosa Rudjakov	Яв Y	6487	"В"(1)	–	–	Рудяков, 1961 5
	l Семейство Myodocopidae						
8.	Actinocyteris sp.	Фил PL	6290–6330	"В"(1)			Беляев, Миронов, 1977а (Шорников) 2 4

Кроме того, из желоба Кермадек ("Gal", ст. 654) был описан [Poulsen, 1962] новый монотипический род донных остракод Hadacypridina и вид H. bruuni Poulsen. В первоописании указана глубина его нахождения 6000 м. Но по уточненному списку станций экспедиции на "Галатее" [Bruun, 1958], глубина этого лова была меньше – 5850–5900 м. Весьма вероятно, однако, что этот вид обитает в желобе Кермадек и глубже 6000 м. Три экземпляра не определенных ближе остракод были найдены в дночерпательной пробе из Алеутского желоба с глубины 7298 м [Jumars, Hessler, 1976].

Пелагические** M

	l Семейство Halocypridae						
9.	Archiconchoecia maculata Chavtur	КК	9500–7280	"В"(1)	–	–	Чавтур, 1977 6
10.	Archiconchoecia sp. n. Rudjakov	Мар M Буг BG	8000–4400 8200–6700	"В"(1) "В"(1)	4400–2500	Мар M	Беляев, 1976 / (Рудяков) 5
11.	Bathyconchoecia paulula pacifica Chavtur	КК	9500–7280 7700–6400 7450–6470 7320–6100 7130–6120 6600–5400	"В"(6)	–	–	Чавтур, 1977 6
12.	Metaconchoecia abyssalis (Rudjakov)	КК	8500–6000 8050–6800 7700–6400 7450–6470 7320–6100 7130–6120 8000–4200 6600–5400	"В"(8)	3000	h То (районы желобов КК, Мар, Кер)	Рудяков, 1962; 5 Беляев, 1976 / (Рудяков); Чавтур, 1977 6
		Мар M	8000–4400	"В"(1)			
		Буг BG	6200–4200	"В"(1)			
		Кер	8000–6200	"В"(1)			
13.	Paraconchoecia mamillata (Müller)***	КК	8500–6000 7700–6400 7450–6470 7320–6100 7130–6120 8000–4200 6600–5400	"В"(7)	760–514 (обычно глубже O 2000 м)	IN Ао, Ио, То	Рудяков, 1962; 5 Чавтур, 1977 6
14.	P. vitjazi (Rudjakov)	КК	9500–7280 h и те же ловы, что и для № 12	"В"(9)	4000	КК	То же 3

*Приведены глубины ловов дночерпателем или донным тралом.

**Приведены горизонты ловов планктонными сетями.

***Тихоокеанская форма, возможно, относится к особому подвиду [Рудяков, 1962].

TABLE 10. MYSIDACEA (BOTTOM-DWELLING SPECIES)

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth
i. Region of encounter
j. Source
l. Family

Column j
1. Birstein, Tchindonova, defined by Ya. I. Birstein
2. Determination of Yu. G. Tchindonova
3. The same
4. Tchindonova

Additionally, 1 specimen of a new species Michthyops sp.n. (or a close new species) was found in the Kuril-Kamchatka trench in a catch by a plankton net from depth about 8,000 m to the surface (Vityaz, st. 3176). The dwelling of this species "judging from the stomach contents, despite the bait in the open trap, is linked more to the bottom than to the pelagia [Tchindonova, 1981, st. 28]. The indication in the cited work for the finding of this Crustacean in the Ryukyu trench is erroneous.

* The genus Birsteiniamysis was isolated by Tchindonova [1981] from the genus Boreomysis and includes 3 species that were previously included in this genus (B. inermis, B. scyphops and B. caeca), as well as several, apparently, new species. However, the diagnosis of the new species has not yet been published, and its name still remains nomen nudum.

**Mysidacea from the Palau trench (Vityaz, st. 7289) was predefined by Yu. G. Tchindonova as Hansenomysis sp. (see: [Beliaev, Mironov, 1977a, p. 13).

Таблица 10

Мизиды – Mysidacea (придонные виды)

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
			l Семейство Mysidae				
1.	Amblyops magna Birst. et Tchindonova	КК	6435–7230	"В"(2)	–	–	Бирштейн, Чиндонова, 1958; определение Я.А. Бирштейна 1
2.	Amblyops sp.n. 1 Tchindonova	Яп YAP Бан B	7190–8720 7335–7340	"В"(2) "В"(1)	– –	– –	Определение Ю.Г. Чиндоновой 2
3.	Amblyops sp.n. 2 Tchindonova	ЮС SS	7200–7216	"АК"(1)	5465	м Скотия SC	То же 3
4.	Amblyops sp.n. 3 Tchindonova	Волк VOLC Яп YAP	6780–6785 7230–7280	"В"(1) "В"(1)	–	–	"
5.	Amblyops sp.n. (?) Tchindonova	Япон JAP	7190	"В"(1)	–	–	"
6.	Birsteiniamysis* sp.n. (?) Tchindonova	ЮС SS	7200–7216	"АК"(1)	5378	м Скотия SC	"
7.	Birsteiniamysis sp. n. (?) Tchindonova	Хьорт	6200–6230	"ДМ"(1) DM	4520	к югу от Новой Зеландии TO THE SOUTH OF NEW ZEALAND	"
8.	Mysimenzies hadalis Băcescu	Пер P	6146–6354	"АВ"(1)	–	–	Băcescu, 1971
9.	Mysimenzies sp.n. 1 Tchindonova	Пал PL	7970–8035	"В"(1)	–	–	Чиндонова, 1981** 4
10.	Mysimenzies sp.n. 2 Tchindonova	Рюкю RYU	7440–7450	"В"(1)	–	–	Определение Ю.Г. Чиндоновой 2
11.	Paramblyops sp.n. Tchindonova	Ал AL Яп YAP	7246 7190–8720	"В"(1) "В"(3)	–	–	Чиндонова, 1981 4
12.	Mysidacea sp.sp.	Пал PL НБ NB Бут BG НГ NH	8021–8042 8258–8266 7847–8662 6758–6776	"SpFB"(1–Ф) "SpFB"(1–Ф) "SpFB"(1–Ф) "SpFB"(1–Ф) P			Lemche et al., 1976

Кроме того, 1 экз. нового вида Michthyops sp.n. (или близкого нового рода) был обнаружен в Курило-Камчатском желобе в улове планктонной сетью с глубины от 8000 м до поверхности ("Витязь", ст. 3176). Обитание этого вида, "судя по содержимому желудка, несмотря на поимку в сквозном лове, больше связано с дном, чем с пелагиалью" [Чиндонова, 1981, с. 28]. Указание в цитированной работе на нахождение этого рачка в желобе Рюкю ошибочно.

* Род Birsteiniamysis Tchindonova [Чиндонова, 1981] выделен из рода Boreomysis и включает 3 вида, ранее входившие в этот род (B. inermis, B. scyphops и B. caeca), а также несколько, по-видимому, новых видов. Однако диагноз нового рода еще не опубликован, и его название пока остается nomen nudum.

** Мизида из желоба Палау ("Витязь", ст. 7289) была предварительно определена Ю.Г. Чиндоновой как Hansenomysis sp. (см.: [Беляев, Миронов, 1977а, с. 13]).

TABLE 11. CUMACEA

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Northeast trench
l. Family

Column j
1. Lomakina
2. The same
3. Beliaev (definition of N. B. Lomakina)
4. Vinogradova et al.
5. Beliaev, Mironov

* This Crustacean was previously noted [Bruun, 1953b, 1955; Wolff, 1960] under the name Diastylis sp. and under the name Makrokylindrus sp.n. [Bacescu, 1962].

Таблица 11

Кумовые ракообразные – Cumacea

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
	l Семейство Bodotriidae	BG					1
1.	Bathycuma sp.n. Lomakina	Бут	6920–7657	"B"(1)	–	–	Ломакина, 1969
2.	Vaunthompsonia aff. cristata Bate	КК	6475–6571	"B"(1)	–	–	То же 2
	l Семейство Dyastilidae	Y					
3.	Makrokylindrus hadalis Jones	Яв	7160	"Gal"(1)	–	–	Jones, 1969*
		JAP					
4.	M. hystrix Gamô	Япон	6380–6450	"HM"(1)	–	–	Gamô, 1985
5.	Makrokylindrus sp.n. Lomakina	С-в k котл То	6065	"B"(1)	–	–	Ломакина, 1969 1
	l Семейство Lampropidae						3
6.	Lamprops sp.n. Lomakina	Яв Y	6820–6850	"B"(1)	–	–	Беляев, 1966б (определение Н.Б. Ломакиной
7.	Paralamprops sp.n. Lomakina	С-в k котл То	6065	"B"(1)	–	–	Ломакина, 1969 1
	l Семейство Leuconidae						
8.	Leucon aff. tenuirostris Sars	С-в k котл То	6065	"B"(1)	–	–	То же 2
9.	Leucon sp.n. Lomakina	Ал AL	7246	"B"(1)	–	–	"
	l Семейство Nannastacidae						
10.	Campylaspis sp.n. Lomakina	С-в k котл То	6065	"B"(1)	–	–	"
11.	Cumacea sp.sp.	ИБ IB	6770–6890	"B"(1)			Menzies et al., 1959; Беляев, 1966б; Виноградова и др., 4 1974; Lemche et al., 1976; Беляев, Миронов, 1977а 5
		Волк VOLC	6330	"B"(1)			
		Мар M	6580–6650	"B"(1)			
		Пал PL	8021–8042	"SpFB" (1–Ф) P			
		НБ NB	7875–7921	"SpFB" (1–Ф) P			
		Бут BG	7984–8006	"B"(1)			
		НГ NH	6758–6776	"SpFB" (1–Ф) P			
		Пер P	6324–6328	"Vema" (1)			
		ЮС SS	6766–7216	"АК"(2)			
		м Скотия SC	5650–6070	"АК"(1)			

* Ранее этот рачек был отмечен [Bruun, 1953b, 1955; Wolff, 1960] под названием Diastylis sp. и под названием Makrokylindrus sp.n. [Băcescu, 1962].

TABLE 191. TANAIDACEA

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Suborder
l. Family

Column 3
1. Northeast trough

Column 8
1. Kudinova-Pasternak
2. Pasternak
3. personal report

Таблица 12

Отряд клешненосные ослики – Tanaidacea

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	k **Подотряд Apseudomorpha**						
	l Семейство Apseudidae						
1.	Apseudes galatheae Wolff	Кер	6660–6770	"Gal"(1)	2320	ANT Ант (То)	Wolff, 1956b; Кудинова-Пастернак, 1 Пастернак, 1981 2
2.	A. zenkevitchi Kud.–Pastern.	1 С-в котл То	6065	"B"(1)	1067	N с То, 1 Карибское м	Кудинова-Пастернак, 1966, 1973; 1 Кудинова-Пастернак, Пастернак, 1978 2
3.	Apseudidae gen.sp.	BG Буг	6920–7657	"B"(1)			Кудинова-Пастернак, личное сообщение 1 3
	l Семейство Gigantapseudidae						
4.	Gigantapseudes adactylus Kud.–Pastern.	Фил PLP	6290–7880	"B"(2)	–	–	Кудинова-Пастернак, 1978 1
	k **Подотряд Neotanaidomorpha**						
	Семейство Neotanaidae						
5.	Herpotanais kirkegaardi Wolff	Кер	6960–7000	"Gal"(1)	–	–	Wolff, 1956b
6.	Neotanais americanus Beddard	ИБ IB	6770–6850	"B"(1)	513	N с Ао, E в То, Ант ANT	Кудинова-Пастернак, 1977; 1 Gardiner, 1975
7.	N. armiger Wolff	Пер P	5986–6134	"Vema"(1)	600	W з Ао (1 Карибское м), E в То	Gardiner, 1975
8.	N. hadalis Wolff	Кер Буг BG ПР PR	6960–8300 6920–7657 8330	"Gal"(2) "B"(1) "AK"(1)	4707	в Ао	Wolff, 1956b; Kudinova-Pasternak, 1965; Кудинова-Пастернак, Пастернак, 1978 1 2
9.	N. insignis Kud.–Pastern.	Мар M	8215–8225	"B"(1)	–	–	Кудинова-Пастернак, 1977 1
10.	N. kurchatovi Kud.–Pastern.*	ЮС SS	7200–7934	"AK"(2)	–	–	Кудинова-Пастернак, 1975б 1
11.	N. serratispinosus (Norm. et Stebbing)	Кер Буг BG Ал AL	6960–8300 6920–7657 6520	"Gal"(2) "B"(1) "B"(1)	677	n с Ао, n с То (4895 м)	Wolff, 1956b; Kudinova-Pasternak, 1965; Кудинова-Пастернак, 1970, 1973 1
12.	N. tuberculatus Kud.–Pastern.	КК ПР PR	7265–7295 6800–7030	"B"(1) "AK"(1)	4116	e в То, Ао (1 Карибское м)	Кудинова-Пастернак, 1976; 1 Кудинова-Пастернак, 1 Пастернак, 1978 2
13.	Neotanais sp. A	JAP Япон	6380–7460	"HM"(2)	–	–	Shin, 1984

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Column 3
1. Northeast trough

Column 7
1. Caribbean Sea
2. Sulawesi

Column 8
4. The same

Таблица 12 (продолжение)

1	2	3	4	5	6	7	8
14.	Neotanais sp. B	JAP Япон	6380	"НМ" (1)	–	–	То же 4
15.	Neotanais sp.	НГ NH	6680–6830	"В" (1)	–	–	Кудинова-Пастернак, 1966, 1970** /
16.	Neotanais (?)	НБ NB	7875–7921	"SpFB" (1–Ф) P			Lemche et al., 1976
	l Семейство Paratanaidae						
17.	Arthrura andriashevi Kud.-Pastern.	l С-в котл То	6065	"В" (1)	4000	n с То	Kudinova-Pasternak, 1967
18.	Heterotanoides ornatus Kud.-Pastern.	JAP Япон	7370	"В" (1)	–	–	Кудинова-Пастернак, 1976 /
	l Семейство Pseudotanaidae						
19.	Cryptocopoides arctica (Hansen)	ИБ IB	6770–6850	"В" (1)	18	ARC Арк, n с Ао, n с То, Ант ANT	Кудинова-Пастернак, 1977 /
20.	Pseudotanais affinis Hansen	ИБ IB	6770–6890	"В" (1)	116	Арк ARC	Кудинова-Пастернак, 1977 /
21.	P. nordenskioldi Sieg	ИБ IB Бан B	6770–6890 7335–7430	"В" (1) "В" (1)	497	S ю Ао, 2 м Сулавеси (5700)	То же 4
22.	P. vitjazi Kud.-Pastern.	Япон JAP l С-в котл То	7370 6065	"В" (1) "В" (1)	4260	n с То	Кудинова-Пастернак, 1966, 1973 /
23.	Pseudotanais sp.	КК	6675–6710	"В" (1)			Кудинова-Пастернак, 1970 /
	l Семейство Tanaidae						
24.	Protanais birsteini (Kud.-Pastern.)	КК	6090–6135	"В" (1)	–	–	То же 4
	k Подотряд Tanaidomorpha						
	l Семейство Agathotanaidae						
25.	Paragathonais typicus Lang	ИБ IB	6770–6890	"В" (2)	3659	/ Карибское м, 2 м Сулавеси (5700)	Кудинова-Пастернак, 1977 /
	l Семейство Anarthruridae						
26.	Anarthruropsis langi Kud.-Pastern.	КК	7795–8015	"В" (1)	–	–	Кудинова-Пастернак, 1976 /
	l Семейство Leptognathiidae						
27.	Colletea cylindrata (G.O. Sars)	КК	6090–6710	"В" (2)	92	n с Ао, n с То (3350 м)	Кудинова-Пастернак, 1970, 1973 /
28.	C. minima (Hansen)	ИБ IB	6770–6890	"В" (1)	1905	n с Ао	Кудинова-Пастернак, 1977 /
29.	Leptognathia angustocephala Kud.-Pastern.	Ром R	6330–7500	"АК" (2)	–	–	Кудинова-Пастернак, 1975а /
30.	L. armata Hansen	Ал AL Буг BG ЮС SS	6520 7974–8006 6052–6150	"В" (1) "В" (1) "АК" (1)	530	ARC Аркт,n с Ао, n с То (3385 м) w з Ио IN (4260–5025 м)	Кудинова-Пастернак, 1970, 1973, 1975б, 1986; Kudinova-Pasternak, 1965 /
31.	L. birsteini Kud.-Pastern.	Буг BG l С-в котл То	6920–7657 6065	"В" (1) "В" (1)	4895	n с То	Kudinova-Pasternak, 1965; Кудинова-Пастернак, 1966, 1970 /

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Key:
Column 3
1. Northeast trough
2. Northwest trough

Column 7
3. Sargasso Sea

Таблица 12 (продолжение)

1	2	3	4	5	6	7	8
32.	L. breviremis (Lilljeb.)?	КК BG	7265–7295***	”В”(1)	–	–	Кудинова-Пастернак, 1970 1
33.	L. caudata Kud.-Pastern.	Буг.	7974–8006	”В”(1)	–	–	Kudinova-Pasternak, 1965
34.	L. dentifera G.O. Sars	КК	6225	”В”(1)	60	n с Ао, n с То (4895 м)	Кудинова-Пастернак, 1970 1
35.	L. dissimilis Lang	ПР PR	5890–6000	”АК”(1)	6000	Саргассово м 3	Lang, 1972; Кудинова-Пастернак, 1 Пастернак, 1978**** 2
36.	L. elegans Kud.-Pastern.	Буг BG	7974–8006	”В”(1)	–	–	Kudinova-Pasternak, 1965
37.	L. gracilis (Krøyer)	КК Япон JAP ЮС SS	6675–6710 7370 6052–7218	”В”(1) ”В”(1) ”АК”(2)	9–443	n с То, nd с и S ю Ао, ANT Ант, W IN з Ио (3923–4957 м)	Кудинова-Пастернак, 1970, 1973, 1975б, 1976, 1986 1
38.	L. greveae Kud.-Pastern.	КК	8185–8400	”В”(1)	–	–	Кудинова-Пастернак, 1976 1
39.	L. langi Kud.-Pastern.	КК	6675–6710	”В”(1)	–	–	Кудинова-Пастернак, 1970 1
40.	L. longiremis Lilljeb.	ИБ IB Ал AL Фил PLP Яв Y	6770–6890 6520 6290–6850 6433–6475	”В”(2) ”В”(1) ”В”(2) ”В”(1)	120	N с Ао, W IN з Ио (4890–5060 м)	Кудинова-Пастернак, 1973, 1976, 1977, 1978, 1986 1
41.	L. longiremis Lilljeb (?)	Кер	8928–9174	”В” (1)*****	–	–	Кудинова-Пастернак, 1972 1
42.	L. microcephala Kud.-Pastern.	VOLC Волк	6330	”В”(1)	–	–	Кудинова-Пастернак, 1977 1
43.	L. parabranchiata Kud.-Pastern.	Пал PL	7000–7170	”В”(1)	–	–	Кудинова-Пастернак, 1977 1
44.	L. paraforcifera Lang	ЮС SS	6052–6150	”АК”(1)	4800	W IN з Ио	Кудинова-Пастернак, 1975б 1
45.	L. robusta Kud.-Pastern.	ИБ IB	6770–6850	”В”(1)	2600	S ю Ао, n с То (4945м)	Кудинова-Пастернак, 1977, 1978 1
46.	L. tuberculata Hansen	2 С-з котл То	6051	”В”(1)	2143	n с Ао, n с То (4895 м)	Кудинова-Пастернак, 1966, 1970 1
47.	Leptognathia sp.	КК	8700–7000******	”В”(1)	–	–	Кудинова-Пастернак, 1970 1
48.	Libanus (?) longicephalus Kud.-Pastern.	ИБ IB	6770–6890	”В”(1)	–	–	Кудинова-Пастернак, 1977 1
49.	Typhlotanais angularis Kud.-Pastern.	1 С-в котл То	6065	”В”(1)	5060	n с То	Кудинова-Пастернак, 1966, 1969 1
50.	T. compactus Kud.-Pastern.	КК 1 С-в котл То	6090–6135 6065	”В”(1) ”В”(1)	800	n с То	Кудинова-Пастернак, 1966, 1970, 1973 1
51.	T. elegans Kud.-Pastern.	VOLC Волк ИБ IB 1 С-в котл То	6330 6770–6850 6065	”В”(1) ”В”(1) ”В”(1)	–	–	Кудинова-Пастернак, 1977 1
52.	T. grandis Hansen	КК	6090–6135	”В”(1)	1264	n с Ао, n с То (4895–5240 м)	Кудинова-Пастернак, 1970******* 1

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Key:
Column 3
3. Central Pacific Ocean trough

*Indicated for the first time under the name N. antarticus (nomen nudum) [Vinogradova et al., 1974].

**In the 1970 publication (p. 348), Kudinova-Pasternak notes that this species is close to N. tuberculatus.

***1 specimen was found in the intestine of an Ascidia caught at this depth; it differs in a number of signs from L. breviremia that is disseminated at depths from 37 to 3,422 m in the North Atlantic.

****The depth of 8,300 m indicated for this species is erroneous.

*****Kudinova-Pasternak [1972] notes that all the Crustacea from the Kermadec trench (9 females) are distinguished by a number of signs from the Atlantic representatives of this species that dwell at depths from 120 to 475 m.

******The only male of this species was taken by a closing plankton net during a catch in the level 8,700-7,000 m. At the beginning of the catch, the net was located at 50-100 m above the bottom. This specimen could not be classified with any of the previously described species.

*******Kudinova-Pasternak notes that all the individuals in this species that were found in the Pacific Ocean are distinguished by the same feature from those described by Hansen from depth 1,264 m from the Atlantic Ocean.

TABLE 13. ISOPODA

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Suborder
l. Family

Column 3
1. Northeast trough

Column 8
1. Beliaev

Таблица 12 (окончание)

1	2	3	4	5	6	7	8
53.	T. kussakini Kud.-Pastern.	КК	6090–6135	"B" (1)	2920	/ Карибское м	Кудинова-Пастернак, 1970; Кудинова-Пастернак, Пастернак, 1978 2
54.	T. mucronatus Hansen	КК	6675–6710	"B" (1)	1620	n с Ао, n с То (3450 м)	Кудинова-Пастернак, 1970, 1973
55.	T. rectus Kud.-Pastern.	l С-в котл То 13	6065	"B" (1)	3610	с То, ю Ао n S	Кудинова-Пастернак, 1966, 1973, 1975, 1976, 1977
		Центр котл То	6400	"B" (1)			
		Vol2 Волк	6330	"B" (1)			
		JAP Япон 2	7370	"B" (1)			
56.	T. setosus Kud.-Pastern.	С-з котл То	6051	"B" (1)	4895	с То n	Кудинова-Пастернак, 1966, 1970
57.	Tanaidacea sp.sp.	НГ NH	6758–6776	"SpFB" (1–Ф) P			Lemche et al., 1976
		НБ NB	7875–7921	"SpFB" (1–Ф) P			

* Впервые был указан под названием N. antarcticus (nomen nudum) [Виноградова и др., 1974].

** В работе 1970 г. (с. 348) Кудинова-Пастернак отмечает, что этот вид близок к N. tuberculatus.

*** 1 экз. был найден в кишечнике пойманной на этой глубине асцидии; по ряду признаков он отличается от L. breviremis, распространенного на глубинах от 37 до 3422 м в Сев. Атлантике.

**** Глубина 8300 м указана для этого вида ошибочно.

***** Кудинова-Пастернак [1972] отмечает, что все рачки из желоба Кермадек (9 самок) отличаются по ряду признаков от атлантических представителей этого вида, обитающих на глубинах от 120 до 475 м.

****** Единственный самец этого вида был пойман замыкающейся планктонной сетью при лове в горизонте 8700–7000 м. При начале лова сеть находилась в 50–100 м над дном. Отнести этот экземпляр к какому-либо из описанных ранее видов не удалось.

******* Кудинова-Пастернак отмечает, что все особи этого вида, обнаруженные в Тихом океане, отличаются по одному и тому же признаку от описанных Ханзеном с глубины 1264 м из Атлантического океана

Таблица 13

Отряд равноногие ракообразные – Isopoda

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	k Подотряд Anthuridea						
	l Семейство Anthuridae						
1.	Leptanthura hendii Wolff	Бан B	6580	"Gal" (1)	–	–	Wolff, 1956a
2.	Leptanthura sp. Birst*	l С-в котл То	6065	"B" (1)	–	–	Беляев, 1966б /

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Key:

Column

2. Birstein
3. Wolff
4. Mezhov
5. Beliaev, Vinogradova
6. Beliaev
7. Beliaev, Mironov

Таблица 13 (продолжение)

1	2	3	4	5	6	7	8
	K Подотряд Asellota						
	l Семейство Desmosomatidae					REGION	
3.	Desmosoma simplex Menzies et George	Пер P	5986–6134	"AB" (1)	3909	Район Пер P	Menzies, George, 1972
4.	D. tenuipes Birst.	КК	6675–6710	"B" (1)	–	–	Бирштейн, 1970 2
	l Семейство Echinothambematidae						
5.	Echinothambema sp. n. Wolff	CAY Kайм (B) Kайм (O) CAY	5800–6850 5900–6780	"AK" (3) "AK" (2)	4600	CARIB. SEA 'Карибское м.	Вольф, 1975; Wolff, 1976b 3
	l Семейство Eurycopidae						
6.	Bathyopsurus nybelini Nordenstamm	ПР PR	7265–7900	"A-2" (1)	4400	Ao, To	Nordenstamm, 1955
7.	Betamorpha acuticoxalis (Birst.)	КК JAP Япон	7210–8400 6156–7587	"B" (4) "B" (3)	4942	n с То	Бирштейн, 1963a, 1970; 2 Межов, 1980 4
8.	Eurycope complanata Bonnier (?)**	ПР PR	6800–7030	"AK" (1)			Вольф, 1975 3
9.	E. curtirostris Birst.	КК JAP Япон	7210–7230 7370	"B" (1) "B" (1)	–	–	Бирштейн, 1963a; 2 Межов, 1980 4
10.	E. eltanie Menz. et George	Пер P	5986–6134	"AB" (1)	3909	REGION Район Пер P	Menzies, George, 1972
11.	E. galatheae Wolff	Кер	6960–7000	"Gal" (1)	–	–	Wolff, 1956a
12.	E. kurchatovi Wilson	ПР PR	6800–7030	"AK" (1)	5260	ПР PR	Wilson, 1982
13.	E. madseni Wolff	Кер	6960–7000	"Gal" (1)	–	–	Wolff, 1956a
14.	E. magna Birst.	Ал AL КК	7246 7210–8345	"B" (1) "B" (7)	–	–	Бирштейн, 1963a, 1970 2
15.	E. ovata Birst.	Япон JAP	7370	"B" (1)	5005	n w с-з То	Межов, 1980 4
16.	E. quadratifrons Birst.	Ром R	7200	"AK" (1)	–	–	Бирштейн, 1969a 2
17.	Eurycope sp. Birst*	Яв Y	6820–6850	"B" (1)	–	–	Беляев, Виноградова, 1961a 5
18.	Eurycope sp. Birst*	Кер	8928–9174	"B" (1)	–	–	Беляев, 1966б 6
19.	Eurycope sp. A Wolff	ПР PR	8330	"AK" (1)	–	–	Вольф, 1975 3
20.	Eurycope sp.	ИБ IB	6770–6890	"B" (1)	–	–	Беляев, Миронов, 1977a*** 7
21.	Munneurycope curticephala (Birst.)	КК	6675–7230	"B" (2)	–	–	Бирштейн, 1963a, 1970 2
22.	M. menziesi Wolff	Кер	6960–7000	"Gal" (1)	–	–	Wolff, 1962
23.	Storthyngura benti Wolff	Кер	6620–7000	"Gal" (3)	5230	Кер	Wolff, 1956a
24.	S. bicornis Birst.	JAP Япон	6156–6207	"B" (1)	–	–	Бирштейн, 1957 2
25.	S. chelata Birst.	КК	6090–6860	"B" (3)	5290	at JAPAN У Японии	Бирштейн, 1957, 1970 2
26.	S. furcata Wolff	Кер	6620–6770	"Gal" (2)	5850	Кер	Wolff, 1956a
27.	S. herculea Birst.	Ал AL КК JAP Япон	7246 6475–9345 6700–7587	"B" (1) "B" (6) "B" (3) "RM" (1)	–	–	Бирштейн, 1957, 1963a, 1970; 2 Suyehiro et al., 1962; Межов, 1980 4
28.	S. pulchra kermadecensis Wolff	Кер	6620–6730	"Gal" (1)	–	–	Wolff, 1962
29.	S. tenuispinis distincta Birst.	КК	6205–6215	"B" (1)	–	–	Бирштейн, 1970 2
30.	S. t. kurilica Birst.	КК	7210–7230	"B" (1)	–	–	Бирштейн, 1957 2

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Column 8

8. The same
9. Beliaev, Mezhov

Таблица 13 (продолжение)

1	2	3	4	5	6	7	8
31.	S.t.tenuispinis Birst.	Ал AL	7246	"В"(1)	–	–	То же 8
32.	S.vitjazi Birst.	КК Япон JAP ИБ IB	6435–8430 6700–7370 7305–7315	"В"(5) "В"(1) "RM"(1) "В"(1)	–	–	Бирштейн, 1957, 1970; 2 Suyehiro et al., 1962; Беляев, 1966б; Межов, 9 1980
33.	S. zenkevitchi Birst.	Ром R	7200	"АК"(1)	–	–	Бирштейн, 1969а 2
34.	Storthyngura sp. n. Birst.*	Яв Y	6820–6850	"В"(1)	–	–	Беляев, Виноградова, 5 1961а
35.	Storthyngura sp. n. Wolff	ПР PR	6400–7030	"АК"(2)	–	–	Вольф, 1975 3
36.	Storthyngura sp. sp.	ИБ IB Волк VOLC	6770–6850 6330	"В"(1) "В"(1)			Беляев, Миронов, 7 1977а
37.	Syneuricope sp. Birst.*	Кер	8928–9174	"В"(1)	–	–	Беляев, 1966б 6
			l Семейство Haploniscidae				
38.	Haploniscus belyaevi Birst.	КК	6090–6225	"В"(2)	2415	NW с-з То	Бирштейн, 1971б 2
39.	H. bruuni Menz. et George	Пер P	5986–6260	"АВ"(2)	3909	P REGION Район Пер	Menzies, George, 1972
40.	H. gibbernasutus Birst.	КК	6435–6710	"В"(1)	5035	NW с-з То	Бирштейн, 1971б 2
41.	H. hydroniscoides Birst.	КК JAP Япон	6675–8120 7370	"В"(2) "В"(1)	4790	NW с-з То	Бирштейн, 1971б; 2 Межов, 1980 4
42.	H. inermis Birst.	КК	8035–8345	"В"(2)	5005	с-з То	Бирштейн, 1971б 2
43.	H. intermedius Birst.	КК	6090–6135	"В"(1)	5005	NW с-з То	То же 8
44.	H. menziesi Birst.	КК	6090–6135	"В"(1)	5035	с-з То	То же 8
45.	H. profundicola Birst.	КК JAP Япон	6090–7710 7370	"В"(2) "В"(1)	–	–	Бирштейн, 1971б; 2 Межов, 1980 4
46.	H. pygmeus Birst.	Ром R	7280	"АК"(1)	–	–	Бирштейн, 1969а 2
47.	H. ultraabyssalis Birst.	Буг BG	6920–8006	"В"(2)	–	–	Бирштейн, 1963б 2
48.	H. cf. unicornis Menz. (?)**	ПР PR	8330	"АК"(1)			Вольф, 1975 3
49.	Haploniscus sp. n. Birst.*	Яв Y	6935–7060	"В"(1)	–	–	Беляев, Виноградова, 5 1961а
50.	Haploniscus sp. 2 Birst.*	TON Тон	10415–10687	"В"(1)	–	–	Беляев, 1966б 6
51.	Haploniscus sp. 3 Birst.*	Кер	8928–9174	"В"(1)	–	–	То же 8
52.	Haploniscus sp. n. Wolff	ПР PR	7430	"JEP"(1)	–	–	Wolff, 1979
53.	Haploniscus sp. sp.	ИБ IB Фил PLP	6770–6850 8440–8580	"В"(1) "В"(1)			Беляев, Миронов, 7 1977а
54.	Hydroniscus vitjazi Birst.	Ал AL КК JAP Япон 2 С-з котл То	7246 6090–6571 6156–6207 6096	"В"(1) "В"(2) "В"(1) "В"(1)	5461	NW с-з То	Бирштейн, 1963а, 2 1971б
55.	Hydroniscus sp.	Яп JAP	7190–7250	"В"(1)			Беляев, Миронов, 7 1977а
56.	Mastigoniscus concavus (Menz. et George)	Пер P	6073–6281	"АВ"(1)	4823	Пер P	Menzies, George, 1972; Lincoln, 1985
57.	M. latus (Birst.)	КК	6435–8400	"В"(5)	5005	NW с-з То	Бирштейн, 1971б; 2 Lincoln, 1985

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Таблица 13 (продолжение)

1	2	3	4	5	6	7	8
			l Семейство Ilyarachnidae				
58.	Ilyarachna defecta Menz, et George	Пер P	6073–6281	"AB"(1)	–	–	Menzies, George, 1972
59.	I. kermadecensis Wolff	Кер	6600–7000	"Gal"(2)	4540	Кер	Wolff, 1962
60.	I. kussakini Birst.	КК JAP Япон	6090–7230 6156–7370	"В"(3) "В"(2)	5461	JAP У Японии	Бирштейн, 1963а, 2 1970; Межов, 1980 4
61.	I. vemae Menz. et George	Пер P	6052–6328	"AB"(5) "Vema"(1)	5742	Пер P	Menzies, George, 1972
62.	Ilyarachna sp. Birst.*	КК	8330–8430	"В"(1)	–	–	Wolff, 1960, 1962
63.	Ilyarachina sp. Birst.*	Кер	8928–9174	"В"(1)	–	–	Беляев, 1966б 1
64.	Ilyarachna sp. Birst.*	Тон TON	10415–10687	"В"(1)	–	–	То же 8
65.	Ilyarachna sp. Menz. et George	Пер P	6324–6328	"Vema"(1)			Menzies, George, 1972
			l Семейство Ischnomesidae				
66.	Haplomesus brevispinus Birst.	КК	6090–6135	"В"(1)	5005	nw с-з То	Бирштейн, 1971б 2
67.	H. concinnus Birst.	КК	6090–6135	"В"(1)	4840	nw с-з То	То же 8
68.	H. consanguineus Mezhov	ИБ IB	8800–8830	"В"(1)	–	–	Межов, 1980 4
69.	H. cornutus Birst.	КК	6475–6571	"В"(1)	–	–	Бирштейн, 1960 2
70.	H. gigas Birst.	КК JAP Япон	6675–8430 6156–7370	"В"(7) "В"(2)	–	–	Бирштейн, 1960, 2 1971б; Межов, 1980 4
71.	H. profundicola Birst.	КК	7265–7295	"В"(1)	–	–	Бирштейн, 1971б 2
72.	H. robustus Birst.	КК	6675–6710	"В"(1)	5005	nw с-з То	То же 8
73.	H. thomsoni (Beddard)	КК	6435–6710	"В"(1)	3751	с-з То	"
74.	Haplomesus sp. 1 Birst.*	1 С-в котл То 1	6065	"В"(1)	–	nw	Беляев, 1966б 1
75.	Haplomesus sp. 2 Birst.*	С-в котл То	6065	"В"(1)	–	–	То же 8
76.	Haplomesus sp. sp.	ИБ IB Волк VOLC 1	6770–6850 6330	"В"(1) "В"(1)			Беляев, Миронов, 7 1977а
77.	Helomesus sp. Birst.*	С-в котл То	6065	"В"(1)	–	–	Беляев, 1966б 1
78.	Heteromesus sp.n.A Wolff	ПР PR	7430–8330	"АК"(1) "JEP"(1)	–	–	Wolff, 1979
79.	Heteromesus sp. n. B Wolff	ПР PR	7938	"JEP"(1)	–	–	То же 8
80.	Ischnomesus andriashevi Birst.	JAP Япон	6156–6207	"В"(1)	4000	JAP У Японии	Бирштейн, 1960 2
81.	I. bruuni Wolff	Кер	6960–7000	"Gal"(1)	–	–	Wolff, 1956a
82.	I. elongatus Birst.	Бут BG	7974–8006	"В"(1)	–	–	Бирштейн, 1963б 2
83.	I. sparcki Wolff	Кер	6660–7000	"Gal"(2)	–	–	Wolff, 1956a
84.	Ischnomesus sp. B Wolff	Кайм CAY (В)	6840–6850	"АК"(1)	–	–	Вольф, 1975 3
85.	Ischnomesus sp. n. Wolff	ПР PR	8330	"АК"(1)	–	–	То же 8
86.	Stylomesus hexatuberculatus Birst.	КК	6050–6135	"В"(1)	5005	nw с-з То	Бирштейн, 1971б 2
87.	S. inermis (Vanhoffen)	Арг A котл TROUGH	6079	"Vema"(1)	2450	S ANT ю Ао, Ант	Menzies, 1962
88.	S. menziesi Birst.	КК	6090–6135	"В"(1)	4852	nw с-з То	Бирштейн, 1971б 2
89.	Stylomesus sp. n. Birst.*	КК	6675–6710	"В"(1)	–	–	То же 8

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Key:
Column 8
9. Vasina, Kussakin
10. Beliaev, Sokolova

Таблица 13 (продолжение)

1	2	3	4	5	6	7	8
90.	Stylomesus sp. 1 Birst.*	С-в котл То	6065	"B"(1)	–	–	Беляев, 1966б 1
	l Семейство Janirellidae						
91.	Janirella erostrata Birst.	Буг BG	7974–8006	"B"(1)	–	–	Бирштейн, 1963б 2
92.	J. fusiformis Birst.	Япон JAP	6156–6207	"B"(1)	–	–	Бирштейн, 1963а
93.	J. macrura Birst.	КК	6435–7230	"B"(2)	–	–	Бирштейн, 1963а, 1971б 2
94.	J. quadrituberculata Birst.	КК	6150	"B"(1)	5290	NW с-з То	Бирштейн, 1963а
95.	J. sedecimtuberculata Gamô	Япон JAP	6350–6450	"HM"(1)	5350	JAP Япон	Gamô, 1983
96.	J. spinosa Birst.	КК Япон	6435–8430 7370	"B"(4) "B"(1)	–	–	Бирштейн, 1963а, 2 1971б
97.	J. tuberculata Birst.	Япон JAP	6380–6450	"HM"(1)	5350	JAP Япон	Gamô, 1983
98.	J. verrucosa Birst.	КК	6205–6215	"B"(1)	5350	Япон JAP	Бирштейн, 1971б; 2 Gamô, 1983
99.	Janirella sp.	ИБ IB	6770–6850	"B"(1)			Беляев, Миронов, 7 1977а
	l Семейство Janiridae						
100.	Acanthaspidia curtispinosa Kussakin et Vasina	ЮС SS	6766–7216	"AK"(2)	–	–	Васина, Кусакин, 9 1982
101.	A. iolanthoidea Kussakin et Vasina	SC м Скотия	5650–6070	"AK"(1)			То же 8
102.	A.cf.decorata Hansen (?)**	ПР PR	6400–7030	"AK"(2)			Вольф, 1975 3
	l Семейство Macrostylidae						
103.	Macrostylis compactus Birst.	Буг BG	6920–7657	"B"(1)	–	–	Бирштейн, 1963б 2
104.	M. curticornis Birts.	КК Япон JAP	6225 6600–6670	"B"(1) "B"(1)	5680	NW с-з То	Бирштейн, 1970; Межов, 1980 4
105.	M. galatheae Wolff	Фил PL	9820–10000	"Gal"(1)	–	–	Wolff, 1956a
106.	M. grandis Birst.	КК	7265–7295	"B"(1)	–	–	Бирштейн, 1970 2
107.	M. hadalis Wolff	Бан B	7270	"Gal"(1)	–	–	Wolff, 1956a
108.	M. longifera Menz. et George	Пер P	5986–6354	"AB"(1)	4823	Пер P	Menzies, George, 1972
109.	M. ovata Birst.	КК	6435–6710	"B"(1)	–	–	Бирштейн, 1970 2
110.	M. profundissimus Birst.	КК	8240–9530	"B"(4)	–	–	То же 8
111.	M. porrecta Mezhov	Яв Y	6433	"B"(1)	–	–	Межов, 1988 4
112.	M. vitjazi Birst.	Буг BG	6920–7657	"B"(1)	–	–	Бирштейн, 1963б 2
113.	M. zenkevitchi Birst.	КК	6090–6135	"B"(1)	4690	NW с-з То	Бирштейн, 1970
114.	Macrostylis sp. n. Wolff	ПР PR	7950–8100	"AK"(1)	5220	ПР PR	Вольф, 1975 3
115.	Macrostylis sp.n. Wolff	ПР	7965	"JEP"(1)	–	–	Wolff, 1979
116.	Macrostylis sp. Birst.*	Мар M	10630–10710	"B"(1)	–	–	Беляев, Соколова, 10 1960а
117.	Macrostylis sp. Birst.*	TON Тон	10415–10687	"B"(1)	–	–	Беляев, 1966б 1
118.	Macrostylis sp. sp.	ИБ IB VOLC Волк Мар M Фил PL	6770–8900 6330–8540 8890–10730 6290–9750	"B"(2) "B"(2) "B"(3) "B" (4)			Беляев, Миронов, 7 1977а

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Key:

Column 8
11. Kussakin
12. Vinogradova et al.

* Here and further, the asterisk indicates the preliminary analyses of the deceased Ya. A. Birstein that refer mainly to new species that remain undescribed.

**Preliminary "conditional" analyses (see: [Wolff, 1975, pp. 224-231]).

***All the data about the genus affiliation of the Isopoda indicated in the publication [Beliaev, Mironov, 1977a] are given in it per the preliminary analyses of F. A. Pasternak.

Таблица 13 (окончание)

1	2	3	4	5	6	7	8
	l Семейство Mesosignidae						
119.	Mesosignum latum Birst.	КК JAP Япон	6090–6135 6380–6450	"В"(1) "НМ"(1)	5005	nw с-з То	Бирштейн, 1970; 2 Gamô, 1983
120.	M. multidens Menz. et Frankenberg	Пер P	5986–6354	"АВ"(3) "Vema"(1)	3372	Пер P	Menzies, Frankenberg, 1968; Menzies, George, 1972
121.	M. vitjazi Birst.	Буг BG	6920–7657	"В"(1)	–	–	Бирштейн, 1963б 2
122.	Mesosignum sp.	Пер P	6002	"Elt"(1)			Menzies, 1963
123.	Mesosignum sp. sp.	ИБ IB VOLC Волк Фил PLP	6770–6890 6330 7420–7880	"В"(2) "В"(1) "В"(1)			Беляев, Миронов, 7 1977а
	l Семейство Munnidae						
124.	Aryballurops japonica Gamô	JAP Япон	6380–6450	"НМ"(1)	–	–	Gamô, 1983
125.	Munna sp.	JAP Япон	6380	"НМ"(1)			Shin, 1984
126.	Zoromunna setifrons Menz. et George	Пер P	5986–6134	"АВ"(1)	–	–	Menzies, George, 1972
	l Семейство Nannoniscidae						
127.	Austroniscoides bougainvillei Birst.	Буг BG	6920–9043	"В"(3)	–	–	Бирштейн, 1963б 2
128.	Austroniscus acutus Birst.	КК	6090–6135	"В"(1)	5005	nw с-з То	Бирштейн, 1970 2
129.	Austroniscus sp. n. Wolff	CAY Кайм (В)	6800–6850	"АК"(2)	–	–	Вольф, 1975 3
130.	Nannoniscus ovatus Menz. et George	Пер P	6321–6328	"Vema"(1)	5586	Пер P	Menzies, George, 1972
131.	N. perunis Menz. et George	Пер P	5986–6134	"АВ"(2)	4823	Пер P	То же 8
132.	Nannoniscus sp.	Пер P	6073–6281	"АВ"(1)			Menzies, Chin, 1966
133.	Nannoniscidae gen. n. sp. n. A Wolff	CAY Кайм (В)	6800	"АК"(1)	–	–	3 Вольф, 1975; Wolff, 1979
134.	Nannoniscidae gen. n. sp. n. B Wolff	ПР PR	8330	"АК"(1)	–	–	То же 8
	k Подотряд Flabellifera						
	l Семейство Cirolanidae						
135.	Cirolana sp.	Пер P	5986–6134	"АВ"(1)			Menzies, George, 1972
	k Подотряд Valvifera						
	l Семейство Arcturidae						
136.	Antarcturus abyssalis Birst.	КК	6090–6135	"В"(1)	5670	nw с-з То	Кусакин, 1971а 11
137.	A. ultrabyssalis Birst.	КК JAP Япон	6435–7230 7190	"В"(2) "В"(1)	–	–	Бирштейн, 1963а 2
138.	A. zenkevitchi Kussakin	КК	6090–6135	"В"(1)	–	–	Кусакин, 1971а 11
139.	Arcturus primus Mezhov	JAP Япон	7370	"В"(1)	–	–	Межов, 1980 4
140.	Arcturidae sp.	SS ЮС	7200–7216	"АК"(1)			Виноградова и др., 1974 12

* Здесь и далее звездочкой отмечены предварительные определения покойного Я.А. Бирштейна, относящиеся в основном к новым видам, оставшимся неописанными.

** Предварительные "условные" определения (см.: [Вольф, 1975, с. 224, 231]).

*** Все данные о родовой принадлежности изопод, указанные в работе [Беляев, Миронов, 1977а], приведены в ней по предварительным определениям Ф.А. Пастернака.

TABLE 14. AMPHIPODA

(The division of representatives of Gammaridea into the leading benthic or bottom-dwelling and pelagic lifestyle was mainly based on the publications: [Barnard, 1962, 1969; Kamenskaya, 1981]; the affiliation of genera to the families is given per [Barnard, 1969] and in specific cases by later publications [Barnard, 1970; Kamenskaya, 1981]. The abbreviations (Column 4) are given by the catching implements: T--benthic trawls or bottom grabs, P--plankton nets or pelagic trawls; L--benthic or bottom traps with bait, P--photography of Crustacea at the bait. For the catches by closing plankton nets, the catch level is indicated, and for the catches by non-closing nets, the depth range of the open trap to the surface).

Таблица 14

Разноногие ракообразные, или бокоплавы, – Amphipoda

(Разделение представителей Gammaridea на ведущих донный или придонный (Дон) и пелагический (Пел) образ жизни проведено в основном по работам: [Barnard, 1962, 1969; Каменская, 1981]; принадлежность родов к семействам дана по [Barnard, 1969]; в отдельных случаях по более поздним работам [Barnard, 1970; Каменская, 1981]. Сокращенные обозначения орудий лова: Т – донные тралы или дночерпатели, Пл – планктонные сети или пелагические тралы, Л – донные или придонные ловушки с приманкой, Ф – фотографирование рачков у приманки. Для ловов замыкающимися планктонными сетями указан горизонт лова, для ловов незамыкающимися сетями – диапазон по глубине сквозного лова до поверхности)

№ п/п a	Вид b	Образ жизни c	Нахождение глубже 6000 м d				Распространение на меньших глубинах i		Источник l
			желоб или котловина e	орудие лова f	глубина, м g	з/с (число нахождений) h	минимальная глубина, м j	район встречаемости k	
1	2	3	4	5	6	7	8	9	10
			m Подотряд Gammaridea						
			n Семейство Ampeliscidae						
1.	Byblis vitjazi Margulis	Дон	С-з котл То	Т	6096	"B" (1)	5680	nw с-з То	Margulis, 1967
2.	Byblisoides arcillis Barnard BENTHIC	Дон?	КК 2 С-в котл То	Т Т	6475–6571 6272–6282	"B" (1) "B" (1)	1560	То	Margulis, 1967; Каменская, 1 1977б
			n Семейство Dexaminidae						
3.	Lepechinella aberrantis (J. Barnard)	Дон	VOLC Волк	Т	6330	"B" (1)	1421	IN То, Ио, Ао	Каменская, 1 1981а
4.	L. ultraabyssalis Birst. et Vinogradova	Дон	КК JAP Япон	Т Т	6475–8015 7370	"B" (2) "B" (1)	–	–	2 3 Бирштейн, Виноградова, 1960; Каменская, 1977в 1
5.	L. vitrea Kamenskaya	Дон	Яп YAP	Т	7190–7250	"B" (1)	–	–	Каменская, 1977а 1
6.	L. wolffi Dahl	Дон	Кер	Т	6660–6770	"Gal" (1)	–	–	Dahl, 1959
			n Семейство Eusiridae						
7.	Eusirus bathybius Schellenberg	Дон	Фил PLP Бут BG ПР PR	Т P Пл Т	7420–7880 7500–0 7625–7900	"B" (1) "B" (1) "A–2" (1)	–	–	Schellenberg, 1955; 3 3 Бирштейн, Виноградова, 1960; Каменская, 1981а 1
8.	Rhachotropis flemmingi Dahl	Дон	Яв Y КК	Т Т	6820–7160 6090–6135	"Gal" (1) "B" (1) "B" (1)	–	–	Dahl, 1959; Беляев 4 3 Виноградова, 1961а; Каменская, 1977б } 1
9.	Rhachotropis sp. n. Kamenskaya*	Дон	Фил PLP	Т	7420–7880	"B" (1)	–	–	Каменская, 1977б, 1981а, б
10.	Rhachotropis (?) sp. Dahl**	Дон	Кер	Т	6960–7000	"Gal" (1)	–	–	Dahl, 1959

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Key:

Column 8/9

1. (3 catches between 3,000 and 6,000)
2. (3 catches: 4,370-2,960, 3,750-1900 and 4,150-0)
3. Widespread at bathyal and abyssal depths

Таблица 14 (продолжение)

1	2	3	4	5	6	7	8	9	10
					n Семейство Gammaridae				
11.	Bathyceradocus stephenseni Pirlot	BENTHIC Дон	Бан B	Т	7250–7340	"Gal"(1) "B"(1)	1165	То, Ио IN	Dahl, 1959; Каменская, 1 1977б, 1981а
			Буг BG	Т	6920–7657	"B" (1)			
12.	Metaceradocoides vitjazi Birst. et Vinogradova	Дон	КК	Т	7210–8345	"B" (4)	–	–	Бирштейн, 2 Виноградова, 3 1960; Каменская, 1 1977в, 1981а
			Япон JAP	Т	6600–7370	"B" (2)			
			ИБ IB	Т	8900	"B" (1)			
			Мар M	Т	8215–8225	"B" (1)			
			Яп JAP	Т	7190–7250	"B" (1)			
					n Семейство Hyperiopsidae				
13.	Hyperiopsis laticarpa Birst, et Vinogradov	PELAGIC Пел	КК	P Пл	8500–6000 7000–6000	"B"(3)	I КК (3 лова между 3000 и 6000), IN Ио (3750–2400 и 3500–0) 4		Бирштейн, 2 Виноградов, 1955б, 19 1964,1970 3
			IB ИБ	Пл	8480–0	"B" (1)			
			Рюкю RYU	Пл	7200–0	"B" (1)			
			Буг BG	Пл	8500–0	"B" (1)			
14.	Parargissa affinis Birst. et Vinogradov	Пел	Буг BG	Пл	8500–0 8150–0	"B"(2)	–	–	Бирштейн, 2 Вино- 3 градов, 1960
15.	P.arcuata Birst. et Vinogradov	Пел	КК	Пл	8500–4200 7000–6000	"B"(2)	КК (6000–5000), IN PL Фил (5300–0), Ио (3 лова: 4370–2 2960, 3750–1900 и 4150–0) 4		Бирштейн, 2 Вино- 3 градов, 1955б, 1958, 1960, 1964, 1970
			ИБ IB	Пл	6500–0	"B" (1)			
			Буг BG	Пл	8500–0 8150–0	"B" (2)			
					n Семейство Ischyroceridae				
16.	Bonnierella linearis J.Barnard	BENTHIC Дон	Пер P	Т	6324–6328	"Vema"(1)	–	–	Barnard, 1964
					n Семейство Liljeborgiidae				
17.	Liljeborgia coeca Birst. et Vinogradova	Дон	JAP Япон	Т	6156–6207	"B" (1)	–	–	2 3 Бирштейн, Виноградова, 1960
					n Семейство Lysianassidae				
18.	Bathycallisoma pacifica Dahl***	PELAGIC Пел	Кер	Т	6960–7000	"Gal"(1)	–	–	Dahl, 1959
19.	Eurythenes grillis (Lichtenst.)	BEN Дон-Пел PEL	ИБ IB	Т	6770–7850	"B" (1)	3 Широко распространен на батиальных и абиссальных глубинах		Каменская, 1 1981а
20.	Hirondellea dubia Dahl	BEN Дон-Пел PEL	Кер	Т	7640–7680	"Gal" (1)	–	–	Dahl, 1959; 2 Бирштейн, Виноградов, 1960 3
				Пл P	7960–6170 9400–0 9120–0	"B" (3)			

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Таблица 14 (продолжение)

1	2	3	4	5	6	7	8	9	10
21.	H.gigas Birst. et Vinogradov	BEN Дон-Пел PEL	КК	P Пл	8500–6000 DEEPER THAN Глубже 7000 7250–0 8000–0 9000–0	"B" (5)	–	–	2 3 Бирштейн, Виноградов, 1955б, 1958, 1970; Dahl, 1959; Wolff, 1976a; Hessler et al., 1978; Каменская, 1977в, 1 1981а
				Т	8035–9345	"B" (3)			
			ИБ IB	Т	6770–8900	"B" (5)			
			Волк VOLC	Т	8530–8540	"B" (1)			
			Яп YAP	Т	8560–8720	"B" (1)			
			Пал PL	Т	7970–8035	"B" (1)			
			Фил PLP	Т PhTr	10020–10190	"Gal"(2) SEVERAL			
				Ф, Л	9604–9806	"TW" (неск.)			
			Мар M	PhTr Ф, Л	7353–10592	"TW" (неск.)			
22.	Onesimoides cavimanus Pirlot	Дон	Бан B	Т	6490–6650	"Gal"(1)		1158м Банда B	Dahl, 1959
23.	Orchomene abyssorum (Stebbing)	BENTHIC Дон	Кер	Т	8210–8230	"Gal"(1)		Абиссаль Abyssal	То же 5
24.	Orchomene (?) sp.	Дон	Мар M	Tr Л	10500	"TW"(1)			Hessler et al., 1978
25.	Paralicella microps (Birst. et Vinogradov)	PELAGIC Пел	КК JAP	P Пл	8000–0	"B" (1)	3700–0	IN Ио	2 3 Бирштейн, Виноградов, 1958, 1960, 1964
			Япон	Пл	6580–0	"B" (1)			
			ИБ IB	Пл	8480–0	"B" (1)			
26.	P.tenuipes Chevreux	Пел	КК	Пл	7000–6000	"B" (1)	NW 4 с-зТо (неск. ловов между 6000 и 3000, 4400–0), а Ао (глубже 1500)		2 3 Бирштейн, Виноградов, 1960, 1970
			Тон TON	Пл	7300–0	"B" (1)			
27.	Schisturella galatheae Dahl	BENTHIC Дон	Кер	Т	6960–7000	"Gal"(1)	–	–	Dahl, 1959
28.	Scopelocheirus schellenbergi Birst. et Vinogradov	Дон-Пел PEL	Ал AL	Т P	6965–7200	"B" (2)	–	–	Schellenberg, 1955; 2 3 Бирштейн, Виноградов, 1958, 1960, 1964, 1970; Каменская, 1977в 1
			КК	Пл	7000–6000	"B" (3)			
					7000–0	"B" (2)			
					8000–0				
			JAP	Т P	6435–6710	"B" (1)			
			Япон	Пл	6580–0	"B" (1)			
				Т P	6380–7370	"B" (3)			
			НГ NH	Пл	8000–0	"B" (1)			
			TON	Т P	6680–6830	"B" (1)			
			Тон	Пл	8120–0	"B" (1)			
				Т	9735–9875	"B" (1)			
			Яв Y	Т	6935–7060	"B" (1)			
			ПР PR	Т	7625–7900	"A–2" (1)			
29.	Tryphosella bruuni (Dahl)	BENTHIC Дон	Кер	Т	6660–6770	"Gal"(1)	–	–	Dahl, 1959
				n	Семейство Paramphithoidae				
30.	Epimeria sp.n. Kamenskaya	Дон	КК	Т	7210–7230	"B" (1)	–	–	1 Каменская, 1977б, 1981б и личное сообщение 6
			Япон JAP	Т	6156–6207	"B" (1)			

Таблица 14 (продолжение)

1	2	3	4	5	6	7	8	9	10
					n Семейство Pardaliscidae		5	IN	2 3
31.	Halice aculeata Chevreux	Пел	КК	Пл	7800–4200 8050–4200 p 6200–0	”В”(3)	Глубже 2000	То, Ио Ао	Бирштейн, Виноградов, 1955б, 1958, 1960, 1964, 1970
	PELAGIC		ИБ IB	Пл	6500–4000	”В”(1)			
			Рюкю RYU	Пл	7200–0	”В”(1)			
			Буг BG	Пл	6500–0	”В”(1)			
			Тон TON	Пл	от 7100– p 10500 до 0	”В”(5)			
32.	H. quarta Birst. et Vinogradov	Пел	КК	Пл	8500–6000 Глубже 0 7000 8000–0	”В”(3)	–	–	Бирштейн, 2 Виноградов, 3 1955б, 1958, 1960, 1970
			IB ИБ	Пл	8480–0 9000–0	”В”(2)			
			Мар M	Пл	10000–0	”В”(1)			
			Тон TON	Пл	9120–0	”В”(1)			
33.	H. rotundata Birst. et Vinogradov	Пел	Буг BG	Пл	6080–4050 8500–0	”В”(2)	5300–0	PLP Фил	Бирштейн, 2 Виноградов, 3 1960, 1963
			Тон TON	Пл	9120–0	”В”(1)			
34.	H. subquarta Birst. et Vinogradov	Пел	Тон	Пл	10500–0	”В”(1)	–	–	Бирштейн, 2 Виноградов, 3 1960; Каменская, 1 1981а
			Кер	Пл	9400–0	”В”(1)			
			Яп YAP	Т	7190–7250	”В”(1)			
			Фил PLP	Т	7420–7880	”В”(1)			
35.	Halice sp. Kamenskaya****	BEN Дон-Пел PEL	Рюкю RYU	Т	7440–7450	”В”(1)	–	–	Каменская, 1 1981а
36.	Pardaliscoides longicaudatus Dahl	Дон	PLP Фил	Т	9820–10000	”Gal”(1)	–	–	Dahl, 1959
			Кер	Т	6180	”Gal”(1)			
37.	Princaxelia abyssalis Dahl	Дон	Ал AL	Т	6965–7000	”В”(1)	–	–	Dahl, 1959; Каменская, 1 1977б, 1981а
			КК	Т	6435–9530	”В”(7)			
			Япон JAP	Т	6380–7370	”В”(2)			
	BENTHIC		ИБ IB	Т	6770–8830	”В”(3)			
			Яп YAP	Т	7190–8720	”В”(2)			
			Фил PLP	Т	7420–7880	”В”(1)			
			Буг BG	Т	7974–8006	”В”(1)			
			Кер	Т	6620–8300	”Gal”(3)			
38.	P. magna Kamenskaya	Дон	Яп YAP	Т	7190–7250	”В”(1)	–	–	Каменская, 1 1977а,б
			Тон TON	Т	7354–8411	”В”(1)			
					n Семейство Phoxocephalidae			n IN	
39.	Harpinia abyssalis Pirlot	Дон	Пер P	Т	6324–6328	”Vema”(1)	780	с Ио, з То W	Barnard, 1964
40.	H. spaercki Dahl	Дон	Бан B	Т	6580–7340	”Gal”(2) ”В”(1)	–		Dahl, 1959; Каменская, 1 1981а
41.	Metaphoxus sp.	Дон	JAP Япон	Т	7550	”НМ”(1)			Shin, 1984
					n Семейство Pontogeneiidae				
42.	Bathyschraderia fragilis Kamenskaya	Дон	Фил PLP	Т	7000–9990	”В”(7)	–	–	Каменская, 1 1981а
43.	B. magnifica Dahl	Дон	Кер	Т	6960–9174	”Gal”(1) ”В”(1)	–	–	Dahl, 1959; Каменская, 1 1977б, в
			TON Тон	Т	7354–9875	”В”(2)			

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Key:
Column 8/9
6. (3 catches in the level 6,000-5,000 and 1 at 5,000-4,000)

Таблица 14 (продолжение)

1	2	3	4	5	6	7	8	9	10
	n Семейство Stegocephalidae								
44.	Andaniexis australis K. Barnard (?)*****	Пел?	Пер P	Т	6324–6328	"Vema"(1)	–	–	Barnard, 1964
45.	A. stylifer Birst. et Vinogradov	P Пел E L	BG Буг	P Пл	От 6500–8500 до 0 P	"B"(4)	–	–	Бирштейн, 2 Виноградов, 3 1960
46.	A. subabyssi Birst. et Vinogradov	Пел A G I C	КК	P Пл	От 8000–8700 до P 7000 От 7000–8500 до P 6000	"B"(2) "B"(3)	–	–	Бирштейн, 2 Виноградов, 3 1955б, 1970
47.	Andaniexis sp. Kamenskaya****	Пел	IB ИБ	Т	6770–6890	"B"(1)	–	–	Каменская, 1 1981а
48.	Phippsiella nipoma J. Barnard	Пел	PLP Фил	Т	6290–6330	"B"(1)	2978	IN То, Ио, Ао	То же 5
49.	Phippsiella sp. n. 1 Kamenskaya	Дон B	JAP Япон	Т	6380	"B"(1)	–	–	Каменская, 1 1977б, 1981б
50.	Phippsiella sp. n. 2 Kamenskaya	Дон E N	КК	Т	7600–7710	"B"(1)	–	–	То же 5
51.	Stegocephalus sp. n. Kamenskaya	Дон T H I	КК	Т	7795–8015	"B"(1)	–	–	"
52.	Steleuthera maremboca J. Barnard	Дон C	P Пер	Т	6324–6328	"Vema"(1)	–	–	Barnard, 1964
	n Семейство Stilipedidae								
53.	Alexandrella carinata (Birst. et Vinogradova)	Дон	КК	Т	7210–7230	"B"(1)	–	–	Бирштейн, 2 Виноградова, 3 1960; Barnard, 1969
	n p Семейство Vitjazianidae								
54.	Vitjaziana gurjanovae Birst. et Vinogradov	PEL Пел	КК	Пл	8000–7000 От 8500–7000 до P 6000	"B"(1) "B"(6)	6 КК (3 лова в горизонте 6000–5000 и 1 – 5000–4000)		Бирштейн, 2 Виноградов, 3 1955б, 1958, 1970; Виноградов, 3 1968
			IB	P	7800–4200	"B"(1)			
			ИБ	Пл	8480–0	"B"(1)			
	m Подотряд Hyperiidae q (все представители этого подотряда – пелагические формы)								
	n p Семейство Lanceolidae								
55.	Lanceola clausi gracilis Vinogradov	PEL Пел	КК	Пл	7000–6000 6500–4300 7800–4200 6200–0 8000–0	"B"(5)	5 Глубже 2000	IN То, Ио	Виноградов, 3 1957, 1962, 1964, 1970б; Бирштейн, 2 Виноградов, 3 1963
			PLP Фил	Пл p	6200–0	"B"(1)			
			Яв Y	Пл	6750–0	"B"(1)			

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It is additionally possible that the following pelagic species dwell below 6,000 m.

Additionally, close not yet defined Amphipoda were found by Akademik Kurchatov research vessel expeditions in the trenches: Chile, 7,200-7,720 m [Beliaev, 1972], South Sandwich from 6,150 to 8,116 m [Vinogradova et al., 1974] and Romanche 7,460-7,600 m [Vinogradova, 1974].

* Based on data of O. Ye. Kamenskaya, this species is also known from the KK and Japan trenches.
**Dahl [1959] believes that it is most likely that the only defective specimen belongs to a new species, and possibly, to a new genus.
***Birstein and Vinogradov [1960] doubt the independence of this species, that differs only slightly from Scopelocheirus schellenbergi, as well as the substantiated isolation of the genus Bathycallisoma. However, Bernard [1969] in the summary list of families and genera Gammaridea leaves this question open, indicating the genus Bathycallisoma as independent (p. 328) and simultaneously noting it as a synonym of Scopelocheirus (p. 362).
****Kamenskaya [1981a] notes abut the species marked with four asterisks that they differ in a number of features from the other species of the same genus.
*****The Crustaceans from the Peru trench differ in a number of features from the Atlantic species A. australis described from the Atlantic Ocean Kapskaya trough from a catch 1,000-0 m [Barnard, 1964]; see also [Birstein, Vinogradov, 1970, p. 410].

Таблица 14 (окончание)

1	2	3	4	5	6	7	8	9	10
56.	L. sphaerica Vinogradov	P E Пел	КК	Пл P	7800–4200 6500–0	"В"(2)	4000–3000	КК	Виноградов, 3 1957, 1970б
57.	Metalanceola chevreuxi Pirlot	L A G I C Пел	BG Буг	Пл	6500–0 8500–0 9000–0	"В"(3)	2000–1000 и 1830–0	IN То, Ио, Ао	Виноградов, 3 1960б, 1964
			TON Тон	Пл	9100–0 10500–0	"В"(2)			
			Кер	Пл	9400–0	"В"(1)			
					n Семейство Scinidae				
58.	Scina wagleri abyssalis Vinogradov	Пел	КК	Пл	8500–6000 7800–4200	"В"(2)	Около 3500	КК	Виноградов, 3 1957, 1960б, 1968, 1970б
			IB ИБ	Пл	8500–0	"В"(1)			
			Кер	Пл	9400–0	"В"(1)			
	Кроме того, возможно, обитают глубже 6000 м следующие пелагические виды								
					m Подотряд Gammaridea				
					n Семейство Eusiridae				
59.	Eusirella longisetosa Birst. et Vinogradov	P E L Пел	BG Буг	P Пл	8500–0	"В"(1)	–	–	Бирштейн, 2 Виноградов, 3 1960
60.	Eusirus fragilis Birst. et Vinogradov	A G I C Пел	TON Тон	P Пл	9120–0	"В"(1)	–	–	То же 5
					n p Семейство Hyperiopsidae				
61.	Hyperiopsis anomala Birst. et Vinogradov	Пел	TON Тон	Пл	6900–0	"В"(1)	–	–	То же 5
62.	Parargissa curticornis Birst. et Vinogradov	Пел	NH НГ	P Пл	7000–0	"В"(1)	–	–	"
63.	P. longipes Birst. et Vinogr.	Пел	BG Буг	P Пл	8500–0	"В"(1)	–	–	"
					m Подотряд Hyperiidea				
					p n Семейство Scinidae				
64.	Scina chelata Vinogradov	Пел	КК	Пл	7750–0	"В"(1)	–	–	Виноградов, 3 1970б

Кроме того, пока не определенные ближе амфиподы были пойманы экспедициями на э/с "Академик Курчатов" в желобах: Чилийском – 7200–7720 м [Беляев, 1972], Южно-Сандвичевом – от 6150 до 8116 м [Виноградова и др., 1974] и Романш – 7460–7600 м [Виноградова, 1974]

*По данным О.Е. Каменской, этот вид известен также из КК и Япон желобов.

**Даль [Dahl, 1959] считает наиболее вероятным, что единственный дефектный экземпляр относится к новому виду и, возможно, к новому роду.

***Бирштейн и Виноградов [1960] сомневаются в самостоятельности этого вида, лишь незначительно отличающегося от Scopelocheirus schellenbergi, а также в обоснованности выделения рода Bathycallisoma. Однако Бернар [Barnard, 1969] в сводном перечне семейств и родов Gammaridea оставляет этот вопрос открытым, указывая род Bathycallisoma как самостоятельный (p. 328) и одновременно отмечая его как синоним Scopelocheirus (p. 362).

****О видах, отмеченных четырьмя звездочками, Каменская [1981а] указывает, что они по ряду признаков отличаются от других видов того же рода.

*****Рачки из Перуанского желоба по ряду признаков отличаются от атлантического вида A. australis, описанного из Капской котловины Ао из улова 1000–0 м [Barnard, 1964]; см. также: [Бирштейн, Виноградов, 1970, с. 410].

TABLE 15. PANTOPODA

*Turpaeva notes [1974] that P. longituberculata individuals from both deep-sea trenches differ significantly from representatives of this species from shallower habitats (the abdomen is shorter than the body respectively by 1.8-2.7 times and 3-5 times).

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Family
Column j
1. Turpaeva

TABLE 16. GASTROPODA
(the system of former subclass Prosobranchia is given per Golikov and Starobogatov [1975]
that is divided it into three independent subclasses)

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Subclass
l. Order
m. Family

Column 8

1. Beliaev, Mironov
2. Moskalev

Таблица 15

Морские пауки – Pantopoda

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
	k Семейство Ammotheidae						
1.	Ascorhynchus birsteini Turpaeva	Пер p	6040	"АК" (1)	–	–	Турпаева, 1971в 1
2.	A. inflatum Stock	м Скотия SC	5565–6070	"АК" (1)	2740	То, ю Ао s	Турпаева, 1974
	k Семейство Colossendeidae						
3.	Colossendeis sp. (ex gr. articulata)	Ал AL	6410–6757	"В" (1)	–	–	Турпаева, 1969
4.	Pantopipetta longituberculata (Turpaeva)	КК ЮС SS	6090–6710 6052–6150	"В" (2) "АК" (1)	3239	NW + S с-з и ю SE То, ю-в Ао	Турпаева, 1971а, 1974*
	k Семейство Nymphonidae						
5.	Heteronymphon profundum Turpaeva	КК Япон JAP	6860 6156–6380	"В" (1) "В" (2)	4915–4985	n с То	Турпаева, 1956, 1971а
6.	Nymphon femorale Fage	Бан B	6490–6650	"Gal" (1)	4040	n IN с Ио	Fage, 1956
7.	N. longitarse caecum Turpaeva	Япон JAP	7370	"В" (1)	–	–	Турпаева, 1971б
8.	N. procerum Hoek	КК	6090–6135	"В" (1)	2450	n + SE с и ю-в То, с и ю Ао	Турпаева, 1971а, 1974 1
9.	N. tripectinatum Turpaeva	Япон JAP	7370	"В" (1)	–	n + S	Турпаева, 1971б

---

* Турпаева [1974] отмечает, что особи P. longituberculata из обоих глубоководных желобов существенно отличаются от представителей этого вида из менее глубоководных местообитаний (абдомен короче туловища соответственно в 1,8–2,7 раза и в 3–5 раз).

Таблица 16

Брюхоногие моллюски – Gastropoda

(система бывшего подкласса Prosobranchia дана по Голикову и Старобогатову
[Golikov, Starobogatov, 1975],
разделившим его на три самостоятельных подкласса)

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
1	2	3	4	5	6	7	8
	k Подкласс Cyclobranchia						
	l Отряд Docoglossa						
	m Семейство Bathypeltidae						
1.	Bathypelta pacifica (Dall)	Яп JAP	8560–8720	"В" (1)	570	То	Беляев, Миронов, 1 1977а (Москалев) 2
	m Семейство Bathysciadiidae						
2.	Bonus petrochenkoi Moskalev	КК Тон TON	8240–9530 8950–9020	"В" (5) "В" (1)	–	–	Москалев, 2 1973

Page 207 Continuation

Key:

Column 8
3. Goryachev
4. The same
5. Vinogradova
6. Lus
7. and personal report
8. Vinogradova et al.

Таблица 16 (продолжение)

1	2	3	4	5	6	7	8
	m Семейство Propilidiidae						
3.	Propilidium reticulatum Moskalev	КК	6090–6135	”В”(1)	500	n + e сив То	Москалев, 1977 2
	k Подкласс Scutibranchia						
	l Отряд Dicranobranchia						
	m Семейство Fissurellidae						
4.	Fissurellidae sp.	Фил PLP	6290–6300	”В”(1)			Беляев, Миронов, 1 1977a (Москалев) 2
	k Подкласс Pectinibranchia						
	l Отряд Alata						
	m Семейство Seguenziidae						
5.	Seguenzia sp.sp.	JAP Яп	7190–7250	”В”(1)			Беляев, Миронов, 1 1977a (Горячев) 3
		Пал P	7000–7170	”В”(1)			
		RYU Рюкю	7440–7450	”В”(1)			
	l Отряд Anisobranchia						
	m Семейство Skeneidae						
6.	Skeneidae sp.	Фил PLP	6290–6330	”В”(1)			Беляев, Миронов, 1 1977a
	m Семейство Trochidae						
7.	Guttula galatheae Knudsen	Кер	6660–6770	”Gal”(1)	–	–	Knudsen, 1964
8.	Trenchia wolffi Knudsen	Кер	6620–6730	”Gal”(1)	5850	Кер	То же 4
9.	Trenchia (?) sp.	RYU Рюкю	7440–7450	”В”(1)			Беляев, Миронов, 1 1977a
10.	Trochidae sp.sp.	Пал P RYU Рюкю	7970–8035 7335–7340	”В”(1) ”В”(1)			То же 4
	l Отряд Aspidophora						
	m Семейство Naticidae						
11.	Naticidae sp.	Ром R	6330–6430	”АК”(1)			5 Виноградова, 1974
	l Отряд Hamiglossa						
	m Семейство Buccinidae						
12.	Callilioncha iturupi Lus	КК	8240–8345	”В”(1)	–	–	Лус, 1989
13.	C. solida Lus	ИБ IB	6770–6850	”В”(1)	–	–	Лус, 1978 6
14.	Paracallilioncha ultra-abyssalis Lus	КК	8035–8120	”В”(1)	–	–	Лус, 1989*
15.	Tacita arnoldi Lus	КК	6090–6135	”В”(1)	5070	n с То	Лус, 1981
16.	T. holoserica Lus	КК JAP Япон	6090–6135 6480–6640	”В”(1) ”В”(1)	–	–	Лус, 1971 и личное сообщение 7
17.	T. zenkevitchi Lus	Пер P	6040	”АК”(1)	5200	P Пер	Лус, 1975 6
18.	Tacita sp.n.Lus	КК	7210–7230	”В”(1)	–	–	6 Лус, (личное сообщение) 7
19.	Tacita sp.sp.	КК JAP Япон	9000–9050 7370	”В”(1) ”В”(1)			То же 4
20.	Buccinidae sp.sp.	КК JAP Япон	6090–8015 6156–6640	”В”(3) ”В”(3)			”
21.	Buccinidae(?) sp.	м Скотия SC	5650–6070	”АК”(1)			8 Виноградова и др., 1974

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Key:
1. Northwest trough
2. Northeast trough

Column 8
1. Beliaev, Mironov
8. The same
12. Lus
13. Moskalev
14. Moskalev
15. personal report

Таблица 16 (продолжение)

1	2	3	4	5	6	7	8
	m Семейство Cancellariidae						
22.	Admete bruuni Knudsen	Кер	6660–7770	"Gal"(1)	–	–	Knudsen, 1964
23.	Cancellariidae sp.	P Пал Бан B	7000–7170 7335–7340	"В"(1) "В"(1)			Беляев, Миронов, 7 1977а
	m Семейство Fasciolariidae						
24.	Thalassoplanes moerchi (Dall)	С-з 1 котл То С-в 2 котл То	6096 6272–6282	"В"(1) "В"(1)	3962	То	12 Лус, 1973**; Bouchet, Waren, 1985
	l Отряд Heterostropha						
	m Семейство Aclididae						
25.	Aclis kermadecensis Knudsen	Кер	8210–8300	"Gal"(1)	–	–	Knudsen, 1964
	m Семейство Piramidellidae						
26.	Piramidellidae sp.sp.	JAP Яп Пал P	7230–7280 7000–7170	"В"(1) "В"(1)			Беляев, Миронов, 7 1977а
	l Отряд Homoeostropha						
	m Семейство Eulimidae (= Melanellidae)						
27.	Melanella hadalis Knudsen	Кер	6660–6770	"Gal"(1)	–	–	Knudsen, 1964
	l Отряд Planilabiata						
	m Семейство Bathyphytophilidae						
28.	Bathyphytophilus caribaeus Moskalev	CAY Кайм (В) CAY Кайм (О)	5800–6500 5900–6300 6740–6780	"АК"(1) "АК"(2)	2450	nw trop с-з, троп То	13 Москалев, 1978
29.	Aenigmabonus kurilo-kamtschaticus Moskalev	КК	6090–8120	"В"(2)	–	–	То же 8
	m Семейство Cocculinidae						
30.	Bandabyssia sp.***	BG Буг	6920–7657	"В"(1)			Москалев, 14 личное сообщение 15
31.	Caymanabyssia spina Moskalev	CAY Кайм (В) B CAY Кайм (О)	6800 6740–6780	"АК"(1) "АК"(1)	–	–	Москалев, 1976 14
32.	Cocculina superba A. Clarke	Арг ARG котл TROUGH	6079	"Vema"(1)	–	–	Clarke, 1960, 1961
33.	Cocculina sp.	ПР PR	7540–7960	"JEP"(?)			Voss, 1969
34.	Fedikovella caymanensis Moskalev	CAY Кайм (В) CAY Кайм (О)	6800 6740–6780	"АК"(1) "АК"(1)	–	–	14 Москалев, 1976
35.	Fedikovella sp.n. 1 Moskalev	ПР PR	7950–8100	"АК"(1)	–	–	14 Москалев, 1976 и личное сообщение 15
36.	Fedikovella sp.n. 2 Moskalev	ПР PR	8330	"АК"(1)	3000	CARIB. Кариб-ское м SEA	То же 8
37.	Pseudococculina sp.n. 1 Moskalev	CAY Кайм (В) CAY Кайм (О)	6800 6740–6780	"АК"(1) "АК"(1)	3700	CARIB. Карибское м SEA	То же**** 8
38.	Pseudococculina sp.n. 2 Moskalev	КК	6090–6135	"В"(1)	4700	с То n	„

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Key:

Column 2
a. Several species close to the undefined

Column 3
1. Northeast trough
2. Northwest trough

Column 8
14. Moskalev
15. personal report
16. Kantor
17. Sysoev

Таблица 16 (продолжение)

1	2	3	4	5	6	7	8
39.	Pseudococculina sp.n. 3 Moskalev	Фил PLP	8080–8400	"В"(1)	–	–	Москалев, 14 личное сообщение 15
40.	Pseudococculina sp.n. 4 Moskalev	Яв Y	6820–6850	"В"(1)	–	–	То же 8
	l Отряд Toxoglossa						
	m Семейство Turridae						
41.	Abyssobela atoxica Kantor et Sysoev	2 С-з котл То	6096–6127	"В"(2)	–	–	16 17 Кантор, Сысоев, 1986
42.	Abyssocomitas kurilo-kamchatika Sys. et Kant.	КК	6090–6117	"В"(1)	5035	КК	17 16 Сысоев, Кантор, 1987
43.	Benthomangelia abysso-pacifica Sysoev	1 С-в котл То	6065	"В"(1)	5502	n с То	17 Сысоев, 1988а
44.	Famelica pacifica Sysoev et Kantor	2 С-з котл То	6096	"В"(1)	–	–	17 16 Сысоев, Кантор, То
45.	Gymnobela angulos Sysoev	2 С-з котл То	6096	"В"(1)	5525	n с То	17 Сысоев, 1988а
46.	G. latistriata Kantor et Sysoev	2 С-з котл То	6096	"В"(1)	4370	n с То	16 17 Кантор, Сысоев, 1986
47.	Kurilohadalia brevis Sysoev et Kantor	КК JAP Япон	7210–8015 6156–6207	"В"(3) "В"(1)	–	–	17 16 Сысоев, Кантор, 1986
48.	K. elongata Sysoev et Kantor	КК	7210–8430	"В"(5)	–	–	То же 8
49.	Oenopota reticulosculp-turata Sysoev	1 С-в котл То	6065	"В"(1)	5005	nw с-з То	17 Сысоев, 1988б
50.	Oenopotella ultraabyssa-lis ultraabyssalis Sysoev	КК JAP Япон	6090–7230 6156–6207	"В"(2) "В"(1)	5740	REGION Район AL Ал	То же 8
51.	O.u. aleutica Sysoev	Ал AL	6965–7000	"В"(1)	–	–	"
52.	Pleurotomella cancellata Sysoev	ИБ IB С-з котл 2 То	6770–6850 6096	"В"(1) "В"(1)	–	–	17 Сысоев, 1988а
53.	Thesbia unica Sysoev	2 С-з котл То	6096	"В"(1)	–	–	То же 8
54.	Tuskaroria ultraabys-salis Sysoev	КК	7210–7230	"В"(1)	–	–	То же 8
55.	Vitjazinella multicos-tata Sysoev	КК 2 С-з котл То	6090–6135 6096	"В"(1) "В"(1)	–	–	17 Сысоев, 1988б
56.	Xanthodaphne bougain-villensis Sysoev	Буг BG	6920–7657	"В"(1)	–	–	17 Сысоев, 1988а
57.	X. laevis Sysoev	Буг BG	7947–8006	"В"(1)	–	–	То же 8
58.	X. palauensis Sysoev	Пал PL	7000–7170	"В"(1)	–	–	"
59.	X. tenuistriata Sysoev	ИБ IB	6770–6850	"В"(1)	–	–	"
60.	Gastropoda Prosobranchia (несколько видов, ближе не определенных) a	VOLC Волк M Мар PLP Фил НГ NH Тон Кер Ром R ЮС SS м Скотия SC	6330 10220–10730 7420–9990 6680–6830 10415–10687 9995–10015 6330–7600 6052–8116 5660–6070	"В"(1) "В"(2) ***** "В"(2) "В"(1) "В"(1) ***** "В"(1) "АК"(2) "АК"(5) "АК"(1)			1 Беляев и др., 1960; Виноградова, 1974; 12 Виноградова и др., 1974 12 Беляев, Миронов, 1977а 7

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Key:
Column 8
16. Minichev

*A photograph of P. ultraabyssalis was published in the book Research Vessel Vityaz and Its Expeditions, [1983, Table V, 3].
**V. Ya. Lus in 1973 described a new genus and species Brevisiphonia circumreta Lus, but in 1985 it was reduced by Bouchet and Waren in synonymy Th. moerchi.
***The genus Bandabyssia was established by Moskalev [1976] for the only species B. costoconcentrica Moskalev, 1976 that was found in the Banda trench (B, st. 6783T, 5° 27 's, 131°39'e) at depth 5,700 m. Judging from the depth, it is quite likely that this species penetrated into the Banda trench also at depths over 6,000 m.
****In the work of T. Wolff [1979], the findings of this species in the western and eastern parts of the Cayman trench are indicated as belonging to different species. During subsequent processing of the material, L. I. Moskalev established that in both cases, specimens of the same species were caught in both cases.
*****Only empty shells were found.

Таблица 16 (окончание)

1	2	3	4	5	6	7	8
	k Подкласс Өpisthobranchia						
	l Отряд Tectibranchia						
	m Семейство Phylinidae						
61.	Phyline sp. 2 Minichev	1 С-в котл То	6065	"В"(1)	2940	n с То	16 Миничев, 1969
62.	Phyline sp. 3 Minich.	Япон JAP	7565–7587	"В"(1)	–	–	То же 8
63.	Phyline sp. 5 Minich.	Ал AL	6410–6757	"В"(1)	–	–	" 5
64.	Phyline sp. 6 Minich.	ЯвYAP	6820–6850	"В"(1)	–	–	Беляев, Виноградова, 1961а (Миничев) 16
65.	Phyline sp. 7 Minich.	ЯвYAP	6820–6850	"В"(1)	–	–	То же 8
	2 m Семейство Retusidae						
66.	Volvula sp. 1 Minich.	С-з котл То	6096	"В"(1)	–	–	16 Миничев, 1969
67.	Volvula sp. 2 Minichev	Буг BG	7974–8006	"В"(1)	–	–	То же 8
	m Семейство Scaphandridae						
68.	Cylichna crispula Watson	1 С-в котл То	6065	"В"(1)	285	CORAL То (Коралловое м)	16 Миничев, 1969
69.	Cylichna sp. 1 Minichev	1 С-в котл То	6065	"В"(1)	–	SEA	То же 8
70.	Cylichna sp. 4 Minichev	ИБ IB	7305–7315	"В"(1)	–	–	"
71.	Tectibranchia sp.sp.	ИБ IB Яп YAP Пал PL ЮС SS м Скотия SC	6770–6850 7230–7280 7000–8035 7206–7934 5650–6070	"В"(1) "В"(1) "В"(2) "АК"(2) "АК"(1)			Беляев, Миронов, 1977а 7

*Фотография P. ultraabyssalis была опубликована в книге "Научно-исследовательское судно "Витязь" и его экспедиции" [1983, табл. V, 3].

**В 1973 г. В.Я. Лус был описан новый род и вид Brevisiphonia circumreta Lus, но в 1985 г. он был сведен Буше и Вареном в синонимию Th. moerchi.

***Род Bandabyssia был установлен Москалевым [1976] для единственного вида B. costoconcentrica Moskalev, 1976, найденного в желобе Банда ("В", ст. 6783Т, 5° 27'ю, 131° 39'в) на глубине 5700 м. Судя по глубине, весьма вероятно, что этот вид проник в желобе Банда и на глубины более 6000 м.

****В работе Т. Вольфа [Wolff, 1979] нахождения этого вида в западной и восточной частях желоба Кайман указаны как относящиеся к разным видам. В процессе последующей обработки материала Л.И. Москалевым было установлено, что в обоих случаях были пойманы особи одного и того же вида.

*****Найдены только пустые раковины.

TABLE 17. SCAPHOPODA

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Order
l. Family

Column d
1. Northwest trough
2. Northeast trough

Column j

1. Chistikov
2. The same
3. Card file of S. D. Chistikov
4. Beliaev
5. Vinogradova

*Scaphophoda from the deep-sea collections of the Soviet expedition were processed by the late S. D. Chistikov, but the results were published only partially [Chistikov, 1982a-c, 1983]. I cite the preliminary analyses of S. D. Chistikov by the Scaphopoda per-station card file that he compiled.

Таблица 17

Лопатоногие моллюски – Scaphopoda

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
		k Отряд Gadilida					
		l Семейство Entalinidae					
1.	Costentalina caymanica Chistikov	CAY Кайм (О)	5900–6300	"АК"(1)	5930	CAY Кайм	Чистиков, 1982б 1
			6740–6780	"АК"(2)			
2.	C. tuscarorae tuscarorae Chistikov	JAP Япон 1	6480–6640	"В"(1)	4995	NW с-з То	То же 2
		С-з котл То	6126	"В"(1)			
3.	C. t. subcentralis Chistikov	С-в котл То 2	6065	"В"(1)	4370	То	"
4.	Entalinidae sp. sp.	КК 1	6090–6675	"В"(2)			Картотека С.Д. Чистикова* 3
		С-з котл То	6096	"В"(1)			
		ЮС SS	6052–6150	"АК"(1)			
		Семейство ?					
5.	Siphonodentalium galatheae Knudsen	Яв Y	6900–7000	"Gal"(1)	–	–	Knudsen, 1964
		l Семейство Gadilidae					
6.	Gadilidae sp. sp.	С-з котл То 1	6096	"В"(1)			Картотека С.Д. Чистикова* 3
		С-в котл То 2	6065	"В"(1)			
		l Семейство Pulsellidae					
7.	Pulsellidae sp.	С-з котл То 1	6160	"В"(1)			То же 2
8.	Scaphopoda (ближе не определенные) 1	JAP Япон	6480–6640	"В"(1)			Беляев 4, Виноградова 5, 1961а; Беляев, 4 1966б; Картотека 3 С.Д. Чистикова*; Виноградова, 1964; 5 Виноградова и др., 5 1964
		Буг BG	6920–7657	"В"(1)			
		С-в котл То 2	6065	"В"(1)			
		Яв Y	6820–6850	"В"(1)			
		Ром R	6330	"АК"(1)			
		м Скотия SC	5650–6070	"АК"(1)			

*Обработка Scaphopoda из глубоководных сборов советских экспедиций проводилась покойным С.Д. Чистиковым, но ее результаты опубликованы лишь частично [Чистиков, 1982а–в, 1983]. Привожу предварительные определения С.Д. Чистикова по составленной им постанционной картотеке скафопод.

TABLE 18. BIVALVIA

(The Bivalvia system is given per Skarlato, Starobogatov [1979] with change per Filatova, Shileyko [1984]; Shileyko [1989]

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Superorder
l. Order
m. Family

Column 3
1. Northwest trench
2. Northeast trench

Column 8
1. Filatova
2. Shileyko
3. and unpublished data
4. The same

Таблица 18

Двустворчатые моллюски – Bivalvia

(Система Bivalvia дана по Скарлато, Старобогатову [1979]
с изменением по Филатовой, Шилейко [1984]; Шилейко [1989])

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
		k Надотряд Protobranchia					
		l Отряд Nuculida					
		m Семейство Ledellidae					
1.	Bathyspinula (Acutispinula) calcar (Dall)	С-з котл То 1	6096	"В" (1)	3610	То, з Ио W IN	1 Филатова, 1958, 1976; Okutani, 1974; 1 Филатова, Шилейко, 1984 2
		С-в котл То 2	6065	"В" (1)			
2.	B.(Bathyspinula) bogorovi (Filatova)	Рюкю RYU	6810	"В" (1)	–	–	1 Филатова, 1958, 1976 и неопубликованные данные 3
		Фил PLP	8080–8400	"В" (1)			
		Япон JAP	7350–7370	"В" (1)			
3.	B.(B.) knudseni (Filatova)	КК	6860	"В" (1)	–	–	1 Филатова, 1976
4.	B.(B.) latirostris Filat. et Schileyko	Япон JAP	7350–7370	"В" (1)	3960	То	1 Филатова, Шилейко, 2 1984
5.	B.(B.) oceanica (Filatova)	Ал AL	6296–6328	"В" (1)	4550	То	1 Филатова, 1958, 1976; Okutani, 1974, 1982, Филатова, 1 Шилейко, 1984 2
		КК	6090–6710	"В" (4)			
		Япон JAP	6165–6207	"В" (1)			
		ИБ IB	7500	"SM" (1)			
		С-з котл 1 То	6090–6320	"SM" (4) "KM" (1)			
		С-в котл 2 То	6060–6282	"В" (1)			
		Пер P	6324–6328	"Vema" (1)			
6.	B.(B.) thorsoni (Filatova)	Ром R	6330–6430	"АК" (1)	5220	ПР PR	1 Филатова, 1976
		ПР PR	6400	"АК" (1)			
7.	B.(B.) vityazi (Filatova)	Ал AL	6965–7250	"В" (2)	–	–	1 Филатова, 1964, 1971, 1976
		КК	6475–9335	"В" (12)			
		Япон JAP	6660–7587	"RM" (1) "В" (3)			
8.	Ledella (Ledella) crassa Knudsen	CAY Кайм (В)	5800–6500	"АК" (1)	3196	e + w в и з Ао, e в То	1 Филатова, 2 Шилейко, 1984
9.	L.(Magaleda) inopinata (Smith)	SC м Скотия	5650–6070	"АК" (1)	2520	SE ю-в Ио, SW ю-з То	То же 4

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Key:

Column 8

5. Beliaev
6. Mironov
7. Vinogradova

* Apparently, species of the ultra-abyssal genus Bathyspinula. The analyses were made before the status of Bathyspinula was raised from subgenus to genus rank.

Таблица 18 (продолжение)

1	2	3	4	5	6	7	8
10.	Ledellina convexirostra Filat. et Schil.	JAP Япон	6600–6670	"В" (1)	4820	n с То	1 2 Филатова, Шилейко, 1984
11.	L. olivacea Fil. et Schil.	Чил Ch	7720	"АК" (1)	5300	e в То	То же 4
12.	Spinula sp.sp.*	ИБ IB	6770–6890	"В" (1)			5 6 Беляев, Миронов, 1977а (Филатова); 1 Виноградова, 1974 7
		Мар M	7340–7450	"В" (1)			
		Яп YAP	7190–7250	"В" (1)			
		Пал PL	7000–7170	"В" (1)			
		Фил PLP	6290–9990	"В" (3)			
		RYU Рюкю	6660–6670	"В" (1)			
		Ром R	6330–6430	"АК" (1)			
13.	Parayoldiella (Intercalaria) mediana Fil. et Schil.	КК	7600–7710	"В" (1)	–	–	1 2 Филатова, Шилейко, 1985
		JAP Япон	7350–7587	"В" (3)			
14.	P.(Parayoldiella) angulata Fil. et Schil.	Мар M	8890–8900	"В" (1)	–	–	То же 4
		Фил PLP	8440–8580	"В" (1)			
15.	P.(P.) hadalis (Knudsen) (= Sarepta hadalis Knudsen)	Фил PLP	10150–10190	"Gal" (1)	–	–	Knudsen, 1970; 2 Филатова, Шилейко, 1985
16.	P.(P.) idsubonini (Filatova)	ИБ IB	8800–8900	"В" (2)	–	–	Филатова, 1971; 2 Филатова, Шилейко, 1985
17.	P.(P.) inflata Filat. et Schil.	Мар M	7340–7450	"В" (1)	–	–	2 Филатова, Шилейко, 1985
		JAP Яп	8560–8720	"В" (1)			
		Пал PL	7970–8035	"В" (1)			
		Фил PLP	8440–9990	"В" (3)			
18.	P.(P.) knudseni Fil. et Schil. (= Yoldiella hadalis Knudsen)	Фил PLP	9820–10000	"Gal" (1)	–	–	Knudsen, 1970; Филатова, Шилейко, 1985 2
19.	P.(P.) ultraabyssalis (Filatova)	КК	8355–9530	"В" (5)	–	–	Филатова, 1971; Филатова, Шилейко, 1985
20.	Parayoldiella (P.) sp. n. Filatova	ЮС SS	8004–8116	"АК" (1)	–	–	Филатова, 1974
21.	Parayoldiella sp.sp.	VOLC Волк	6330–8540	"В" (2)			5 6 Беляев, Миронов, 1977а (Филатова)
		Пал PL	7000–7170	"В" (1)			
		Фил PLP	7610–9750	"В" (2)			

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* По-видимому, виды ультраабиссального рода Bathyspinula. Определения были проведены до повышения статуса Bathyspinula с подродового до родового ранга.

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Key:

Column 8
8. personal report

** In the work of Vinogradova et al. [1974], these Mollusca are indicated under the name Neilo sp.
*** It is possible that some of these species are from the family Ledillidae (A. A. Shileyko, personal report).

Таблица 18 (продолжение)

1	2	3	4	5	6	7	8
	M Семейство Malletiidae						
22.	Malletia cuneata (Jeffreys)	JAP Япон	6156–6207	"В" (1)	1977	ALL Все океаны OCEANS	Knudsen, 1970
23.	Malletia sp.n. Filat.**	SS ЮС	7200–7934	"АК" (2)	–	–	1 Филатова, 1974
24.	Malletia sp.sp.	КК	6860–7230	"В" (2)			5 Беляев, 1966б; 5 Беляев, Миронов, 6 1977а (Филатова); 1 Филатова, 1974 1
		JAP Япон	7565–7587	"В" (1)			
		1 С-з котл То	6096	"В" (1)			
		2 С-в котл То	6272–6282	"В" (1)			
		Пал PL	7970–8035	"В" (1)			
		Фил PLP	6290–7880	"В" (2)			
		RYU Рюкю	6660–6670	"В" (1)			
		SC м Скотия	5650–6070	"АК" (1)			
	m Семейство Nuculanidae						
25.	Neilonella hadalis Knudsen	Кер	6660–7000	"Gal"(2)	–	–	Knudsen, 1970
26.	Neilonella sp.sp.	Ал AL	7246	"В" (1)			5 Беляев, 1966б (Филатова); 1 Филатова, 1974 1
		КК	6475–8430	"В" (2)			
		SC м Скотия	5650–6070	"АК" (1)			
27.	Yoldia kermadecensis Knudsen	Кер	8210–8300	"Gal"(1)	–	–	Knudsen, 1970
28.	Yoldiella sp.sp.***	2 С-в котл То	6065	"В" (1)			5 Беляев, 1966б 1 (Филатова); Филатова, 1974 1
		ЮС SS	6875	"АК" (1)			
29.	Nuculanidae gen.et sp. nov. Filatova	Тон TON	10415–10687	"В" (1)	–	–	5 Беляев, Виноградова, Филатова, 1960 7 1
		Кер	8928–9174	"В" (1)			
30.	Nuculanidae gen. et sp. nov. Filatova	Яв Y	6820–6850	"В" (1)	–	–	1 Филатова, 1961
	m Семейство Tindariidae						
31.	Tindaria sp.sp	Ал AL	6296–7286	"В" (3)			5 Беляев, 1966б; 5 Беляев, Миронов, 6 1977а (Филатова) 1
		КК	7210–7230	"В" (1)			
		ИБ IB	6770–6890	"В" (1)			
		2 С-в котл То	6065–6282	"В" (2)			
32.	SUBORDER Подотряд Nuculina fam., gen, sp.? (= Phaseolus faba Knudsen)	Кер	6960–7000	"Gal"(1)	–	–	Knudsen, 1970; 2 Шилейко, личное сообщение 8

** В работе Виноградова и др. [1974] эти моллюски указаны под названием Neilo sp.

*** Возможно, какие-то виды из семейства Ledellidae (А.А. Шилейко, личное сообщение).

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**** Pourtalesia heptneri Mironov were found attached to sea urchin spines.

Таблица 18 (продолжение)

1	2	3	4	5	6	7	8
	K Надотряд **Autobranchia**						
	l Отряд **Lucinida**						
	m Семейство Montacutidae						
33.	Montacuta sp.sp.****	Бан B	7130–7340	"В" (2)			Миронов, 1978б 6
34.	Montacutidae sp.sp.	PLP Фил	6290–8580	"В" (2)			5 Беляев, Миронов, 6 1977а (Филатова) /
	m Семейство Mytilidae						
35.	Dacridium sp.	SS ЮС	6050–6150	"АК" (1)			Филатова, 1974 /
	m Семейство Thyasiridae						
36.	Axinopsis sp.	JAP Япон	6156–6207	"В" (1)			5 Беляев, 1966б (Филатова) /
37.	Axinulus aff. pygmaeus Dall	Яв Y	6820–6850	"В" (1)	–	–	Филатова, 1961 /
38.	Axinulus sp.n. Filatova	Яв Y	6841–7060	"В" (2)	–	–	То же 4
39.	Axinulus sp.n. Filat.	TON Тон	10415–10687	"В" (1)	–	–	5 Беляев, Виноградова, 7 Филатова, / 1960
		Кер	8928–10015	"В" (2)			
40.	Axinulus sp.sp.	Ал AL	6460–7285	"В" (2)			5 Беляев, 1966б; 5 Беляев, Миронов, 6 1977а (Филатова) /
		КК	6150–9050	"В" (2)			
		JAP Япон	7350–7587	"В" (2)			
		VOLC Волк	8530–8540	"В" (1)			
		Пал PL	7000–7170	"В" (1)			
		Буг BG	7974–9043	"В" (2)			
		Кер	9995–10015	"В" (1)			
	l Отряд **Pectinida**						
	m Семейство Limariidae						
41.	Lima sp.sp.	КК	9000–9050	"В" (1)			5 Беляев, 1966б (Филатова) /
		JAP Япон	6156–6207	"В" (1)			
		ИБ IB	9715–9735	"В" (1)			
		Вит V	6135	"В" (1)			
	m Семейство Pectinidae						
42.	Cyclopecten (Hyalopecten) hadalis Knudsen	Кер	6620–7000	"Gal" (2)	–	–	Knudsen, 1970
43.	Cyclopecten sp.	SC м Скотия	5650–6070	"АК" (1)			/ Филатова, 1974

****Обнаружены прикрепленными к иглам морских ежей Pourtalesia heptneri Mironov.

Page 216 (Continuation)

*****These species were previously known only in shoal findings. Whole specimens of both species were found in the Banda trench in Pandanaceae that were brought to the surface.

Таблица 18 (продолжение)

1	2	3	4	5	6	7	8
44.	Delectopecten randolphi (Dall)	JAP Япон	6156–6207	"В"(1)	18	То	1 Филатова, 1961; 5 Беляев, 1966б (Филатова) 1
		Яв Y	6820–6850	"В"(1)			
45.	Delectopecten sp.	КК	6860–8100	"В"(2)			5 Беляев, 1966б (Филатова) 1
46.	Propeamussium sp.sp.	Ал AL	6410–7246	"В"(2)			То же 4
		КК	7210–7230	"В"(1)			
		Буг BG	7974–8006	"В"(1)			
		НГ NH	6680–6830	"В"(1)			
47.	Pectinidae sp.	Ром R	6330–6430	"АК"(1)			Виноградова, 1974 7
	l Отряд Venerida						
	M Семейство Pholadidae						
48.	Xylophaga grevi Knudsen	Бан B	7250–7290	"Gal"(1)	545	1 Индо-Малайский архипелаг	Knudsen, 1961
49.	X. hadalis Knudsen	Кер	6660–6770	"Gal"(1)	–	–	То же 4
50.	Xylophaga sp.	2 С-в котл То	6272–6282	"В"(1)			5 Беляев, 1966б
	Семейство Teredinidae*****						
51.	Bankia carinata (Gray)	Бан B	7250–7290	"Gal"(1)	SHOAL Мелководье	IN То, Ио, Ао	Knudsen, 1970
52.	Uperotus clavus (Gmelin)	Бан B	7250–7290	"Gal"(1)	То же THE SAME	IN То, Ио	То же 4
	Семейство Vesicomyidae						
53.	Vesicomya bruuni Filat.	Кер	6620–9174	"В"(1) "Gal"(4)	5850–5900	Кер	Филатова, 1969; 1 Knudsen, 1970
54.	V. profundi Filatova	Ал AL	7246	"В"(1)	–	–	Филатова, 1971 1
		КК	7210–9050	"В"(9)			
55.	V. sergeevi Filatova	КК	6090–9530	"В"(11)	–	–	То же 4
56.	V. sundensis (Knudsen)	Яв Y	6820–7000	"Gal"(1) "В"(2)	–	–	Knudsen, 1970; Филатова. 1961 1
57.	Vesicomya sp.sp.	JAP Япон	6156–7587	"В"(3)			Беляев, 1966б; 5 5 Беляев, Миронов, 6 1977а (Филатова); 1 Виноградова, 1974 7
		VOLC Волк	6330	"В"(1)			
		Мар M	10700–10730	"В"(1)			
		Ром R	6330–7600	"АК"(3)			

*****Эти виды ранее были известны только по мелководным нахождениям. В желобе Банда целые экземпляры обоих видов были найдены в поднятых со дна плодах пандануса.

Page 217 (end)

Key:
9. Ivanova

Таблица 18 (окончание)

1	2	3	4	5	6	7	8
	k Надотряд Septibranchia						
	l Отряд **Cuspidariida**						
	m Семейство Cuspidariidae						
58.	Cuspidaria hadalis Knudsen	Бан B	6580–7210	”Gal”(2)	–	–	Knudsen, 1970
59.	Myonera sp.	С-в котл 2 То	6065	”В” (1)			5 Беляев, 1966б (Филатова) / 5
60.	Cuspidariidae sp.sp.	Япон JAP	7565–7587	”В” (1)			Беляев, 1966б; 5 Беляев, Миронов, 6 1977а (Филатова); / Виноградова, 7 1974
		Волк VOLC	6330	”В” (1)			
		Мар M	8215–8225	”В” (1)			
		Яп YAP	7190–7250	”В” (1)			
		Пал PAL	7970–8035	”В” (1)			
		Фил PLP	6290–9990	”В” (4)			
		Рюкю RYU	6660–6670	”В” (1)			
		Буг BG	7974–8006	”В” (1)			
		Ром R	7460–7600	”АК” (1)			
	l Отряд **Verticordiida**						
	m Семейство Verticordiidae						
61.	Laevicordia sp.	ЮСSS	6050–6150	”АК” (1)			Филатова, 1974 /
62.	Lyonsiella sp.sp.	КК	8175–8840	”В” (2)			5 Беляев, 1966б (Филатова) /
		С-в котл 2 То	6272–6282	”В” (1)			
63.	Polycordia (Angustebranchia) extenta V. Ivanova	КК	8185–8400	”В” (1)	–	–	Иванова, 1977 9
64.	P.(A.) laevigata V. Ivanova	КК	8060–8400	”В” (3)	–	–	То же 4
65.	P.(A.) maculata V. Ivanova	КК	9000–9050	”В” (1)	–	–	„
66.	P.(A.) rectangulata V. Ivanova	КК	8175–9335	”В” (4)	–	–	„
67.	Polycordia (A.) sp.1 V. Ivanova	КК	8610–8660	”В” (1)	–	–	„
68.	Polycordia (A.) sp. 2 V. Ivanova	КК	8175–8840	”В” (1)	–	–	„
69.	P. (Latebranchia) ovata V. Ivanova	Пер P	6040	”АК” (1)	5740	n с То	„
70.	Polycordia sp.	ЮСSS	7200–7216	”АК” (1)			Филатова, 1974 /
		SC м Скотия	5650–6070	”АК” (1)			
71.	Polycordia sp.	Фил PLP	6290–6330	”В” (1)			5 Беляев, Миронов, 6 1977а (Филатова) /

TABLE 19. SIPUNCULA

Key:
a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Family

Column j
1. Murina
2. Trip logs

* A. Bruun [1955] indicated that Sipuncula were also caught in the Kermadec trench at depth 8,200 m, but this is probably an erroneous indication since Sipuncula were not indicated [Wolff, 1960] in a more detailed list of the catch composition from this station (Galathea, st. 649, 8,210-8,300 m).

Таблица 19

Сипункулиды – Sipuncula

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с f (число нахождений)	минимальная глубина, м h	район встречаемости i	
		k Семейство Golfingiidae					
1.	Golfingia (Golfingia) anderssoni (Théel)	КК	6090–6135	”В”(1)	75	nw с-з То, Ант ANT	Мурина, 1971
2.	G.(G.) muricaudata (Southern)	КК	6090–6860	”В”(4)	150	Ао, То, Ант ANT	Мурина, 1964, 1969, 1971
		Япон JAP	6156–6214	”В”(1)			
3.	G.(Nephasoma) improvisa (Théel)	КК	6090–6135	”В”(1)	9	Ао, Ио, IN То	Мурина, 1971
4.	G.(N.) minuta (Keferstein)	КК	6090–6710	”В”(5)	0	IN То, Ио, Арк, Ант ARC ANT	Мурина, 1958 а, б, 1969, 1971, 1974
		Япон JAP	6380	”В”(1)			
		С-в котл То	6065	”В”(2)			
		ЮС SS	6052–6150	”АК”(1)			
		SC м Скотия	5650–6070	”АК”(1)			
5.	G.(N.) schuttei (Augener)	КК	6090–6235	”В”(1)	0	IN То, Ио, S ю Ао	Мурина, 1971, 1973
		Чил Ch	7000	”АК”(1)			
6.	G.(N.) sectile Murina	ЮС SS	6052–6150	”АК”(1)	–	–	Мурина, 1974
7.	Phascolion lutense Selenka	Ал AL	6296–6328	”В”(1)	1820	n с То, IO Ио, ю Ао S	Мурина, 1957, 1961, 1969, 1971, 1974
		КК	6090–6860	”В”(5)			
		Япон JAP	6156–6207	”В”(1)			
		С-в котл То	6065–6282	”В”(2)			
		Яв Y	6820–6850	”В”(1)			
		ЮС SS	6052–6150	”АК”(1)			
8.	Ph.pacificum Murina	Ал AL	6296–6328	”В”(1)	1330	n с То, S ю Ао, Ант ANT	Мурина, 1957, 1969, 1971, 1974
		КК	6090–6860	”В”(4)			
		Япон JAP	6600–6670	”В”(1)			
		С-в котл То	6065–6282	”В”(2)			
		SC м Скотия	5650–6070	”АК”(1)			
9.	Sipuncula* (ближе не определенные) not defined	Ал AL	6520	”В”(1)			Рейсовые журналы; 2 Frankenberg, Menzies, 1968; Jumars, Hessler, 1976
			7298	”TW”(1)			
		Япон JAP	6600–6670	”В”(1)			
		Пер P	6040–6229	”АК”(1) ”АВ”(1)			

*А. Бруун [Bruun, 1955] указал, что сипункулида была также поймана в желобе Кермадек на глубине 8200 м, но, вероятно, это указание ошибочно, так как в более подробном списке состава улова с этой станции (’Галатея”, ст. 649, 8210–8300 м) сипункулида не указана [Wolff, 1960].

TABLE 20. ASTEROIDEA*

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Order
l. Family

Column 3
1. Northeast trough
2. Northwest trough

Column 8
1. Korovchinskiy
2. Beliaev
3. The same
4. Vinogradova
7. Mironov

Таблица 20

Морские звезды – Asteroidea*

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
1	2	3	4	5	6	7	8
	k Отряд Brisingida						
	l Семейство Freyellidae						
1.	Freyella kurilo-kamchatica Korovchinsky	КК JAP Япон С-в котл 1 То	6205–6860 6156–6207 6272–6282	”B”(2) ”B”(1) ”B”(1)	4890	NW с-з То	Коровчинский, 1976 а 1
2.	F. mortenseni Madsen	Кер	6180	”Gal”(1)	5850	Кер	Madsen, 1956b 1
3.	F. mutabila Korovchinsky	SC м Скотия	5650–6070	”AK”(1)	4664	м Скотия	Коровчинский, 1976б 1
4.	Freyellidae sp.sp.	НБ NB Бут BG НГ NH	7875–8260 7847–8662 6758–6776	”SpFB” (2–Ф) ”SpFB” (1–Ф) ”SpFB” (1–Ф)		SC	Lémche et al., 1976
	k Отряд Paxillosida						
	l Семейство Astropectinidae						
5.	Dytaster inermis Sladen	2 С-з котл То	6096	”B”(1)	3930	W з То	Беляев, 1966б, 1972 2
6.	D.sp.(aff. nobilis Sladen)	2 С-з котл То	6096	”B”(1)	–	–	То же 3
	1 l Семейство Porcellansteridae						
7.	Abyssaster tara (Wood-Mas. et Alcock)	С-в котл То	6272–6282	”B”(1)	3200	n IN с То, Ио	Беляев, 1966б 2
8.	Albatrossia richardi (Koehler)	TROUGH Котл ЗелМ ZM	6035	”PrAl”(1)	5600	TROUGH Котл ЗелМ ZM	Koehler, 1909; Madsen, 1961a; Беляев, 2 1985а
9.	Albatrossia sp.	Ал AL С-в котл 1 То	6296–6328 6065	”B”(1) ”B”(1)			Беляев, 1985а 2
10.	Eremicaster crassus (Sladen)	Ал AL С-в котл 1 То	6296–6328 6065	”B”(1) ”B”(1)	2418	IN То, Ио	Беляев, 2 1966б, 1985б
11.	E. vicinus (Ludwig)	Ал AL КК JAP Япон ИБ IB Пер P Кер	6296–7246 6090–6860 6700–7340 6770–6890 6006–6328 6620–6730	”B”(3) ”B”(5) ”RM” (1) ”B”(2) ”Vema”(1) ”Elt”(1) ”AK”(2) ”ДМ”(1) ”Gal”(1)	3949	IN То, Ио, Ао Ант ANT	Menzies et al., 1959; Wolff, 1960; Madsen, 1961a; 2 Беляев, 4 Виноградова, 1961a; Suyehiro et al., 1962; Menzies, 1963; Беляев, 2 1966б, 1972, 1985б; 4 Виноградова и др., 1974; Беляев, 2 Миронов, 7 1977 а

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Key:
Column 3
1. Northeast trough
2. Northwest trough

Column 8

5. Moskalev
6. Pasternak

*Family Freyellidae were isolated by M. Downey in 1986. The division into orders is from D. B. Blake [1987].
**Tentative determination from hillocks noted on underwater photographs obtained on silt with broad crater-like hole.

Таблица 20 (продолжение)

1	2	3	4	5	6	7	8
		1 С-в котл То	6272–6282	"В"(1)			
		Яв Y	6433–7000	"Gal"(1) "В"(2)			
		ЮС SS	6052–6150	"АК"(1)			
		SC м Скотия	5650–6070	"АК"(1)			2
12.	Lethmaster rhipidophorus Belyaev	Рюкю RYU	6460–7540	"В"(4)	–	–	Беляев, 1969б, 1985а
		Фил PLP	7420–7880	"В"(1)			
13.	Porcellanaster ivanovi Belyaev	Волк VOLC	7584–7614	"В"(1)	–	–	То же 3
		Яп YAP	8560–8720	"В"(1)			
		Пал PL	7000–8035	"В"(2)			2 4
14.	Porcellanaster sp.sp.	Ал AL 1 С-в котл То	6296–6328 6065	"В"(1) "В"(1)			Беляев, 1972; Виноградова и др., 1974
		ЮС SS	6052–6150	"АК"(1)			2 5
15.	Styracaster longispinus Belyaev et Moskalev	Ал AL	6296–6328	"В"(1)	4995	с То	Беляев, Москалев, 1986 2
16.	Styracaster sp.n. (=S.elongatus sensu Madsen, 1981)	CAY Кайм (О)	6466–6600	"Gil"(1)	–	–	Madsen, 1981; Беляев, 1985а
17.	? Porcellanasteridae**	НБ NB	7057–7078	"SpFB" (1–Ф)			Lemche et al., 1976
		НГ NH	6758–6776	"SpFB" (1–Ф)			
		k Отряд Valvatida					
		PL l Семейство Goniasteridae					
18.	? Litonaster sp.	Пал	8021–8042	"SpFB" (1–Ф)			Lemche et al., 1976
		k Отряд Velatida					
		CAY l Семейство Caymanostellidae					2
19.	Caymanostella spinimarginata Belyaev	Кайм (О)	6740–6780	"АК"(1)	–	–	Беляев, 1974
		l Семейство Pterasteridae					
20.	Hymenaster blegvadi Madsen	Кер	6660–6770	"Gal"(1)	–	–	Madsen, 1956b
21.	Hymenaster sp.sp.	КК	6090–8400	"В"(8)			2 Беляев, 1966б, 1972;
		JAP Япон	6380	"В"(1)			6 Пастернак, 1968; Ви- 4
		ИБ IB	6770–6890	"В"(1)			ноградова, 1974; Ви- 4
		Волк VOLC	7584–7657	"В"(1)			ноградова и др., 1974;
		Яп YAP	8560–8720	"В"(1)			Lemche et al., 1976;
		Пал PL	7000–7170	"В"(1)			2 Беляев, Миронов, 7 1977а
		Пал PL	8021–8042	"SpFB" (1–Ф)			
		Фил PLP	8440–9990	"В"(2)			
		Буг BG	6920–7657	"В"(1)			
		НГ NH	6758–6776	"SpFB" (1–Ф)			
		2 С-з котл То	6096	"В"(1)			
		Ром R	6330–7600	"АК"(4)			
		ЮС SS	6052–6150	"АК"(1)			

*Семейство Freyellidae выделено М. Доуней в 1986 г. [Downey, 1986]. Деление на отряды по Д.Б. Блейку [Blake, 1987].

**Предположительное определение по заметным на подводных фотографиях, полученных на илистом грунте, бугоркам с широким кратеровидным отверстием.

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TABLE 21. OPHIUROIDEA

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Order
l. Family

Column 3
1. Northeast trough
2. Northwest trough

Column 8
1. Beliaev
2. Litvinova
3. Mironov
4. personal report

Таблица 21

Офиуры – Ophiuroidea

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	k Отряд Ophiurae						
	l Семейство Ophiacanthidae						
1.	Ophiacantha opercularis (Koehler)	Котл ЗелМ TROUGH ZM	6035	"PrAl"(1)	–	–	Koehler, 1909
2.	O. bathybia H.L. Clark	КК	6090–6235	"B" (2)	800	n с То	1 Беляев, 2 Литвинова, 1972
3.	Ophiocymbium cavernosum Lyman	ИБ IB С-в котл 1 То	6770–6850 6065	"B" (1) "B" (1)	2644*	n с Ао, S ю Ио	1 Беляев, 3 Миронов, 1977а; Литвинова, 2 личное сообщение 4
4.	Ophiocymbium sp.n. Litvinova	ИБ IB Фил PLP	6770–6850 7420–7880	"B" (1) "B" (1)	–	–	2 Литвинова, личное сообщение 4
5.	? Ophiacanthidae	НГ NH	6758–6776	"SpFB" (1–Ф)			Lemche et al., 1976
	l Семейство Ophiodermatidae						
6.	Ophiurochaeta sp.	ЮС SS	6052–6150	"AK" (1)			2 Литвинова, личное сообщение 4
	l Семейство Ophioleucidae						
7.	Bathylepta pacifica Bel. et Litvinova	Буг BG НГ NH 1 С-в котл То	6920–8006 6680–6830 6065	"B" (2) "B" (1) "B" (1)	5740	AL Ал	1 Беляев, 2 Литвинова, 1972.
	l Семейство Ophiuridae						
8.	Abyssura brevibrachia Bel. et Litvinova	Ал AL КК JAP Япон	6965–7000 6675–7295 6156–6207	"B" (1) "B" (3) "B" (1)	–	–	1 Беляев, 2 Литвинова, 1976
9.	Amphiophiura bullata bullata (W. Thomson) (= Ophioglypha abdita Koehler)	котл ЗелМ TROUGH ZM ПР PR	6035 5890–6035	"PrAl"(1) "AK" (1)	2268*	Ао	Koehler, 1909; Madsen, 1951; 2 Литвинова, 1975
10.	A. bullata pacifica Litvinova	КК JAP Япон 2 С-з котл То 1 С-в котл То	6090–6235 6390 6096 6065–6282	"B" (2) "B" (1) "B" (1) "B" (2)	5027 (2507–2607)**	n с То	2 Литвинова, 1971
11.	A. convexa (Lyman)	Рюкю RYU 2 С-з котл То 1 С-в котл То	6810 6096 6065	"B" (1) "B" (1) "B" (1)	1950	Ао, IN Ио, То	2 Литвинова, 1971 (Paterson, 1985)***
12.	A. vitjazi Litvinova	Рюкю RYU	6810	"B" (1)	–	–	2 Литвинова, 1971****

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Key:

Column 8
5. The same
6. Vinogradova

Additionally, at 17 stations on the Vityaz and Akademik Kurchatov expeditions, below 6,000 m sometimes fairly numerous Ophiuroidea of the family Amphiuridae were found (a closer definition has not been made): in the Kuril-Kamchatka, Aleutian, Japan, Peru trenches and in the northeast Pacific Ocean trough, as well as in the southern Atlantic Ocean, in the South Sandwich trench and in the South Atlantic trough (Scotia Sea). The greatest depth of finding Ophiuroidea of this family is 6,860 m.

Undefined fragments or juvenile specimens close to Ophiuroidea have been found at more than 10 stations by expeditions on Vityaz, Dmitriy Mendeleyev, Galathea, Vema and Eltanin in depth ranges from 6,006 to 8,120 m.

*Per [Peterson, 1985].

**This subspecies was described from 441 specimens of 17 findings in the northern Pacific Ocean; 16 of these findings and 440 specimens are known from depths from 5,027 to 6,380 m, and only a single specimen was found at depth 2,507-2,607 m to the north of Vancouver Island, where a general rise is observed of deep-sea fauna to lower depths [Litvinova, 1971].

***The species A. convexas is known from numerous findings, predominantly, at depths over 4,500 m; only a few findings of single specimens are known from lower depths. Paterson [1958] does not consider A. convexa an independent species, but a subspecies of A. bullata.

****A.vitjazi was described by Litvinova in a single specimen from the Ryukyu trench. Paterson [1985] believes this species to be one of the subspecies of A. bullata and indicates another 3 findings (579 specimens) in the Zeleniy Mys trough (Central Atlantic) at depths from 5,867 to 5,880 m. He notes, however, that in the specimens he studied the marginal disc plates "are often indistinct and are covered with thickened skin surrounding each plate" (p. 133). This does not correspond to the original description and image of A. vitjazi. It is therefore more likely that the Atlantic specimens belong to a different species.

Таблица 21 (окончание)

1	2	3	4	5	6	7	8
13.	Amphiophiura sp.	ЮС SS SC м Скотия	6052–6150 5650–6070	"АК" (1) "АК" (1)			2 Литвинова, личное 4 сообщение
14.	Homalophiura madseni Bel. et Litvinova	КК Япон JAP	6675–7230 6156–6380	"В" (2) "В" (2)	–	–	Беляев /, Литвинова 2, 1972
15.	H. aff. madseni Litvinova	Рюкю RYU Пал PL Мар M	7440–7450 7000–7170 7340–7450	"В" (1) "В" (1) "В" (1)	–	–	Литвинова 2, личное 4 сообщение
16.	Homalophiura sp.n.1 Litvinova	С-з котл 2 То	6096	"В" (1)	–	–	То же 5
17.	Homalophiura sp.n.2 Litvinova	КК	6475–6571	"В" (1)	–	–	»
18.	Ophiocten sp.n. Litvin.	SC м Скотия	5650–6070	"АК" (1)	–	–	»
19.	Ophiotypa simplex Koehler	Яв Y	6477–6487	"В" (1)	2670	IN Ао, Ио, То	Литвинова 2, 1975
20.	Ophiura bathybia H.L. Clark	Ал AL КК	6296–6328 6090–6135	"В" (1) "В" (1)	2870	N с То	Беляев /, Литвинова 2, 1972
21.	O. loveni (Lyman)	Кер Ром R	6660–6770 6330–7340	"Gal" (1) "АК" (2)	2510	S-e ю-в То, ю Ио S IN	Madsen, 1956b; Беляев /, Литвинова 2, 1972; Виноградова, 6 1974
22.	O. irrorata irrorata (Lyman)	С-з котл 2 То SC м Скотия	6096 5650–6070	"В" (1) "АК" (1)	91	IN Ао, Ио, То	Беляев /, Литвинова 2, 1972; Литвинова, 2 личное сообщение 4
23.	O. irrorata polyacantha Mortensen	ЮС SS	6052–6150	"АК" (1)	3651	Ао	Литвинова 2, личное сообщение 4
24.	Ophiurolepis sp.	ЮС SS	6052–7216	"АК" (3)			То же 5
25.	Perlophiura profundissima Bel. et Litvinova	Ал AL КК ИБ IB Волк VOLC	7200 6795–8135 6770–6890 6330	"В" (1) "В" (2) "В" (2) "В" (1)	2265	IN То, Ио, Ао	Беляев /, Литвинова 2, 1972; Литвинова, 2 1975; Беляев, / 3 Миронов, 1977а
26.	Ophiuridae sp.sp.	Буг BG НГ NH	7847–8662 6758–6776	"SpFB" (1–Ф) "SpFB" (1–Ф)			Lemche et al., 1976

Кроме того, на 17 станциях экспедициями на "Витязе" и "Академике Курчатове" найдены глубже 6000 м иногда довольно многочисленные офиуры семейства Amphiuridae (ближе пока не определенные): в желобах Курило-Камчатском, Алеутском, Японском, Перуанском и в Северо-восточной котловине Тихого океана, а также в южной части Атлантического океана – в Южно-Сандвичевом желобе и в Южно-Антильской котловине (море Скотия). Наибольшая глубина нахождения офиур этого семейства – 6860 м.

Не определенные ближе офиуры, фрагменты или ювенильные экземпляры найдены еще более чем на 10 станциях экспедициями на "Витязе", "Дмитрии Менделееве", "Галатее", "Виме" и "Илтенине" в диапазоне глубин от 6006 до 8120 м.

*По [Paterson, 1985].

**Этот подвид был описан по 441 экз. из 17 нахождений в северной части Тихого океана; 16 из этих нахождений и 440 экз. известны с глубин от 5027 до 6380 м, и лишь единственный экземпляр был найден на глубине 2507–2607 м к северу от острова Ванкувер, где вообще наблюдается подъем глубоководной фауны на меньшие глубины [Литвинова, 1971].

***Вид A. convexa известен по многочисленным нахождениям преимущественно на глубинах более 4500 м; лишь немногие нахождения единичных экземпляров известны с меньших глубин. Патерсон [Paterson, 1985] считает A. convexa не самостоятельным видом, а подвидом A. bullata.

****A. vitjazi был описан Литвиновой по единственному экземпляру из желоба Рюкю. Патерсон [Paterson, 1985] считает этот вид одним из подвидов A. bullata и указывает еще 3 нахождения (579 экз.) в котловине Зеленого Мыса (Центральная Атлантика) на глубинах от 5867 до 5880 м. Однако он отмечает, что у изученных им экземпляров краевые пластинки диска "часто неразличимы (indistinct) и покрыты уплотненной кожей, окружающей каждую пластинку" (p. 133). Это не соответствует первоописанию и изображению голотипа A. vitjazi. Поэтому наиболее вероятно, что атлантические особи относятся к другому виду.

Table 22. Holothurioidea

Таблица 22

Голотурии – Holothurioidea

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	k Отряд Apoda						
	l Семейство Myriotrochidae						
1.	Lepidotrochus kermadecensis (Belyaev)	Кер	8928–9174	"В" (1)	–	–	Беляев 1, 1970; Беляев 1, Миронов 2, 1980
2.	L. variodentatus (Bel. et Mironov)	SS ЮС	6766–7934	"АК" (2)	–	–	Беляев 1, Миронов 2, 1978, 1980
3.	Myriotrochus longissimus Bel.	JAP Япон Фил PLP Пал PL	6475–7370 6290–6330 7000–7170	"В" (4) "В" (1) "В" (1)	5422	1 С-в котл То	Беляев 1, 1970; Беляев 1, Миронов 2, 1977б
4.	M. macquariensis Bel. et Miron.?	Хьорт Hjort	6420–6650	"ДМ" (1)	–	–	Беляев 1, Миронов 2, 1981
5.	M. mitis Bel.	Кер	8928–9174	"В" (1)	–	–	Беляев 1, 1970
6.	Prototrochus angulatus (Bel. et Miron.)	Фил PLP	7610–9990	"В" (3)	–	–	Беляев 1, Миронов 2, 1977б, 1982
7.	P. bipartitodentatus (Bel. et Miron.)	ЮС SS	7694–8116	"АК" (2)	–	–	Беляев 1, Миронов 2, 1978
8.	P. bruuni (Hansen)*	Фил PLP Пал PL ИБ IB Буг BG TON Тон Кер Яв Y	9360–10210 7970–8035 8900–9180 8940–9043 8950–10687 8928–10015 6487–7060	"Gal"(3) "В" (1) "Arch"(1) "В" (1) "Gal"(1) "В"(1) "В" (2) "В" (2) "В" (2)	–	–	Hansen, 1956; Cherbonnier, 1964; Беляев 1, 1970; Беляев 1, Миронов 2, 1977б
9.	P. kurilensis (Bel.)	КК	7795–8430	"В" (4)	–	–	Беляев 1, 1970
10.	P. wolffi (Bel. et Miron.)	Мар M VOLC Волк Яп YAP	8215–8225 8530–8540 8560–8720	"В"(1) "В" (1) "В" (1)	–	–	Беляев 1, Миронов 2, 1977б
11.	P. zenkevitchi zenkevitchi (Bel.)	КК JAP Япон ИБ IB	8175–9530 7500 8800–9735	"В" (7) "В" (1) "В" (2)	–	–	Беляев 1, 1970; Беляев 1, Миронов 2, 1977б
12.	P.z. atlanticus (Bel. et Miron.)	Ром R	7430–7600	"АК" (2)	–	–	Беляев 1, Миронов 2, 1981
13.	P.z. exiguus (Bel.)	КК	8060–8135	"В" (1)	–	–	Беляев 1, 1970
14.	P. zenkevitchi (Bel.)?	Чил Ch	7720	"АК" (1)	–	–	Беляев 1, Миронов 2, 1977б, 1982
15.	P.sp. (aff. longissimus) (Bel. et Mir.)	ЮС SS SC м Скотия	6052–6150 5650–6070	"АК" (1) "АК" (1)	–	–	Беляев 1, Миронов 2, 1978
16.	Prototrochus sp.n. Belyaev**	Мар M	10630–10730	"В" (2)	–	–	Беляев 1, 1970; Беляев 1, Миронов 2, 1977б, 1982

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Таблица 22 (продолжение)

1	2	3	4	5	6	7	8
17.	Prototrochus sp.n.? Bel. et Miron.	SC м Скотия	5650–6070	"АК" (1)	–	–	1 2 Беляев, Миронов, 1978
18.	Siniotrochus spiculifer Bel. et Mir.?	КК	8330–8430	"В" (1)	–	–	1 2 Беляев, Миронов, 1981
	K Отряд **Aspidochirota**						
	l Семейство Synalactidae						
19.	Mesothuria murrayi (Théel)	B Бан	6490–6650	"Gal"(2)	254	n с То, Индо-Малайский архипелаг	Hansen, 1956
20.	Paroriza grevei Hans.	B Бан	6490–7290	"Gal"(3)	–	– IN	То же 3
21.	Pseudostichopus villosus Théel	Кер	6660–7000	"Gal"(2)	896	То, Ио, Ао	„
22.	P. villosus Théel(?)	НБ NB	7875–8260	"SpFB" (2–Ф)			Lemche et al., 1976***
		Бут BG	6758–6776	"SpFB" (1–Ф)			
		СК	8712–8930	"SpFB" (1–Ф)			
23.	Pseudostichopus sp.	КК	8100	"В" (1)			4 Ушаков, 1952
	K Отряд **Elasipoda**						
	l Семейство Elpidiidae						
24.	Amperima naresi (Théel)	Яв Y	6820–7160	"Gal"(1) "В"(1)	2010	IN То, Ио, Ао	Hansen, 1956; 5 Беляев, Виноградова, 1961а; Гебрук, 6 личное сообщение 7
		Пер P	6200–6240	"АК" (1)			
25.	A. velacula Agatep	ЮС SS	6052–6150	"АК" (1)	131	ANT Ант 6	Гебрук, личное сообщение 7
		м Скотия SC	5650–6070	"АК" (1)			
26.	A. vitjazi Gebruk	С-з котл 2 То	6096	"В" (1)	4300	e в То 6	Гебрук, 1988
27.	Ellipinion galatheae (Hansen)	Фил PLP	9820–10000	"Gal"(1)	–	–	Hansen, 1956, 1975
28.	Elpidia atakama Bel.	Чил Ch	7720	"АК" (1)	–	–	1 Беляев, 1971б
29.	E. birsteini Bel.	КК	8060–9345	"В" (6)	–	–	То же 3
		ИБ IB	8530–8540	"В" (1)			
30.	E. decapoda Bel.	м Скотия SC	5650–6070	"АК" (1)	4631	SC м Скотия	1 Беляев, 1975
		ЮС SS	6052–6150	"АК" (1)			
31.	E. hanseni hanseni Bel.	КК	8610–9530	"В" (8)	–	–	1 Беляев, 1971б, 1972
32.	E.h. idsubonensis Bel.	ИБ IB	8800–9735	"В" (3)	–	–	1 1 Беляев, 1971б; Беляев, Миронов, 2 1977а
33.	E. javanica Bel.	Яв Y	6820–6850	"В" (1)	–	–	1 Беляев, 1971б
34.	E. kermadecensis Hans.	Кер	6620–8300	"Gal"(2)	–	–	Hansen, 1956
35.	E. kurilensis Baranova et Bel.	КК	6675–8100	"В" (3)	–	–	1 Беляев, 1971б
		Япон JAP	6156–7587	"В" (4) "RM"(1)			
		Ал AL	6410–6757	"В" (1)			

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Таблица 22 (продолжение)

1	2	3	4	5	6	7	8
36.	E. lata Belyaev	ЮС SS	8004–8116	”АК” (1)	–	–	1 Беляев, 1975
37.	E. longicirrata Belyaev	КК	8035–8345	”В” (2)	–	–	1 Беляев, 1971б
38.	E. ninae Belyaev	ЮС SS	6766–7934	”АК” (3)	–	–	1 Беляев, 1975
39.	E. solomonensis Hansen	Буг BG	7947–9043	”Gal”(2) ”В” (2)	–	–	Hansen, 1956; 1 Беляев, 1971б; Lemche et al., 1976
			7847–8662	”SpFB” (1–Ф)			
		НБ NB	7057–8260	”SpFB” (3–Ф)			
40	E. sundensis Hansen	Яв Y	6433–7160	”Gal”(2) ”В”(2)	–	–	Hansen, 1956; 1 Беляев, 1971б
41.	E. uschakovi Belyaev	НГ NH	6680–6830	”В” (1)	–	–	1 Беляев, 1971б; Lemche et al., 1976
			6758–6776	”SpFB” (1–Ф)			
42.	Elpidia sp. 3 Belyaev	Ром R	7340	”АК” (1)	–	–	1 Беляев, 1971б
43.	Elpidia sp. (aff. minutissima Belyaev)	Яп YAP	8560–8720	”В” (1)	–	–	Lemche et al., 1976;
		Пал PL	7970–8042	”В” (1)			1 Беляев, Миронов, 2 1977а
			8021–8042	”SpFB” (1–Ф)			
44.	Kolga hyalina Danielssen et Koren	КК	6205–6215	”В” (1)	600	ARK Арк, n с Ао	6 Гебрук, личное сообщение 7
		ЮС SS	6052–6150	”АК” (1)			
45.	Peniagone azorica Marenzeller (?)	НБ NB	7057–7921	”SpFB” (2–Ф) P	1385	n·e с-в Ао, То at (у Кер)	Heezen et al., 1964; Lemche et al., 1976
		Буг BG	7847–8662	”SpFB” (1–Ф)			
		Ром R	7100–7300	”Chain” (1–Ф)			
46.	P. gracilis (Ludwig)	Ал AL	6965–7250	”В” (3)	1135	То, Ао	6 Гебрук, личное сообщение 7
		ИБ IB	6770–7315	”В” (3)			
47.	P. herouardi Gebruk	ПР PR	7950–8100	”АК” (1)	–	–	6 Гебрук, 1988
		ЮС SS	7694–7934	”АК” (1)			
48.	P. incerta (Théel)	КК	6090–7230	”В” (3)	2293	ANT Ант	6 Гебрук, личное сообщение 7
		JAP Япон	6156–6207	”В” (1)			
		ЮС SS	6052–6875	”АК” (2)			
49.	P. purpurea (Théel)	Пал PL	8021–8042	”SpFB” (1–Ф) P	2934	ANT Ант	Lemche et al., 1976
50.	P. vedeli Hansen	Кер	6140–8300	”Gal”(5)	–	–	Hansen, 1956****
51.	Peniagone sp.sp.	КК	6090–8400	”В” (4)			Madsen, 1955; Menzies, 1963; 8 Пастернак, 1968; 1 Беляев, 1972; Виноградова, 1974; 9 Виноградова и др., 1974; 9 1 Беляев, Миронов, 2 1977а
		JAP Япон	7565–7587	”В” (1)			
		ИБ IB	7305–7315	”В” (1)			
		Мар M	6580–6650	”В” (1)			
		Пер P	6002–6030	”Elt”(1–Ф)			
		Ром R	6330–7600	”АК” (4)			
		ПР PR 2	6290–7960	”Alb-2”(1) ”JEP”(1) DM ”ДМ” (1)			
52.	Psychroplanes obsoleta (Herouard)	С-з котл То	6096	”В” (1)	4275	Ао	6 Гебрук, 1988

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Key:
a. Number in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Order
l. Family

Column 3
1. Northeast trough
2. Northwest trough

Column 7
1. Malaysian archipelago

Column 8
1. Beliaev
2. Mironov
3. The same
4. Uschakov
5. Vinogradova
6. Khebruk
7. personal report
8. Pasternak
9. Vinogradova
10. These authors

Holothurioidea of the family Gephyrothuriiadae have also been found by Vityaz expeditions at over 20 stations in the following trenches: Al, KK, Jap, IB, Volc, M, Yap, PL, PLP, NH and Kep, and by the expedition on Dmitriy Mendeleyev in the PR trench. The greatest depth at which Holoturioidea of this family were encountered was 10,630-10,710 m in the Mariana trench [Beliaev, Sokolova, 1960]. Other representatives of the order Molpadonia were found by Soviet expeditions in a number of Pacific Ocean trenches and in the Yavan trench at depths to 6,570 m.

Lemche et al. [1976] on numerous photographs of the floor obtained by the Spencer F. Baird research vessel in several west Pacific Ocean trenches found multiple feces of Holothurioidea (several types, differing in shape) and traces left by different Holothurioidea on the ground.

* Possibly, a combined species, specimens from different trenches are distinguished by certain signs.

**These Myriotrochidae were previously noted by us as P. bruuni, but judging from the absence of trochoids in the body skin of all the specimens found at the two stations, this is most likely an independent species.

***Analyses from photographs of the floor with animals or their traces.

****The subsequent works of Hansen [1967, 1975] put P. vedelli in synonymy with P. azorica that is widespread in the Atlantic Ocean at depths from 1,385 to 4,020 m, and also include in this species Peniagone specimens collected by Galathea in the Kermadec trench area, starting from depth 2,640 m. However, judging from Hansen's pictures from all three publications, of the very unique skin spicules of the specimens from the Kermadec trench from depths over 6,000 m, it is more correct to consider P. vedeli a separate species in its initial volume. Gebruk [1986] upheld this same viewpoint.

Таблица 22 (окончание)

1	2	3	4	5	6	7	8
53.	Scotoplanes hanseni Gebruk	КК AP	6090–6860	"B" (2)	4800	То	Hansen, 1956, 1975;
		Япон	6480–6640	"B" (1)			6 Гебрук, 1983;
		НБ NB	7057–7075	"SpFB" (1–Ф)			Lemche et al., 1976
		Буг BG	6920–7660	"B" (1)			
		НГ NH	6680–6830	"B" (1)			
			6758–6776	"SpFB" (1–Ф)			
		Кер	6180–6770	"Gal"(3)			1 2
54.	Elpidiidae sp.sp.	Фил PLP	8440–9990	"B" (3)			Беляев, Миронов, 1977а
	l Семейство Psychropotidae						
55.	Benthodytes sanguinolenta Théel	Бан B	6490–7290	"Gal"(2)	768	IN То, Ио	Hansen, 1956
56.	Psychropotes verrucosa (Ludwig)	Бан B	6490–7290	"Gal"(2)	2417	IN То, Ио	Hansen, 1956, 1975
57.	Psychropotes sp.sp.	Пер P	6260	"AB" (1Ф)			Menzies et al., 1973;
		КК	6090–6215	"B" (2)			Данные автора 10
58.	Psychropotidae gen.et sp.n.	КК	9170–9335	"B" (1)	–	–	Данные автора 10
	l Семейство Pelagothuriidae						
59.	Pelagothuria natatrix Ludwig (?)	НГ NH	6758–6776	"SpFB" (1–Ф)			Lemche et al., 1976
	k Отряд Molpadonia						
	l Семейство Gephyrothuriidae						
60.	Hadalothuria wolffi	НБ NB	7057–7071	"SpFB" (1–Ф)	–	–	Hansen, 1956; Lemche et al., 1976
		Буг BG	8780–8940	"Gal"(2)			
		НГ NH	6758–6776	"SpFB" (1–Ф)			
61.	Hadalothuria sp.	КК	9070–9530	"B" (2)	–	–	Данные автора 10
	l Семейство Molpadiidae						
62.	Ceraplectana trachyderma H.L. Clark	Бан B	6490–6650	"Gal"(2)	3188	То	Hansen, 1956

Кроме того, голотурии сем. Gephyrothuriidae найдены экспедициями на "Витязе" более чем на 20 ст. в желобах: Ал, КК, Япон, ИБ, Волк, Мар, Яп, Пал, Фил, НГ, Кер и экспедицией на "Дмитрии Менделееве" в желобе ПР. Наибольшая глубина нахождения голотурий этого семейства 10 630–10 710 м в Мар желобе [Беляев, Соколова, 1960]. Другие представители отряда Molpadonia найдены советскими экспедициями в ряде желобов Тихого океана и в Яв желобе на глубинах до 6570 м.

Лемхе с соавторами [Lemche et al., 1976] на многочисленных изученных ими фотографиях дна, полученных э/с "Спенсер Ф. Бэрд" в нескольких желобах западной части Тихого океана, многократно обнаруживали фекалии голотурий (несколько типов, различающихся по форме) и следы, оставленные разными голотуриями на грунте.

*Возможно, сборный вид – экземпляры из разных желобов различаются по некоторым признакам.

**Эти мириотрохиды ранее были предварительно отмечены нами как P. bruuni, но, судя по отсутствию колес в коже тела у всех найденных на двух станциях экземпляров, это, скорее всего, самостоятельный вид.

***Определения по фотографиям дна с животными или их следами.

****В последующих работах Хансен [Hansen, 1967, 1975] сводит P. vedelli в синонимию P. azorica, распространенного в Атлантическом океане на глубинах от 1385 до 4020 м, и включает в этот вид также особей Peniagone, собранных "Галатеей" в районе желоба Кармадек, начиная с глубины 2640 м. Однако, судя по приводимым Хансеном во всех трех работах рисункам весьма своеобразных спикул кожи особей из желоба Кермадек с глубин более 6000 м, P. vedeli правильнее считать самостоятельным видом в его первоначальном объеме. Эта же точка зрения принята и Гебруком [1986].

TABLE 23. ECHINOIDEA

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Order
l. Family

Column d
1. Northwest trough
2. Northeast trough

Column j
1. Mironov
2. The same
3. Beliaev
4. personal report

*This species was indicated for the first time by Madsen under the name Pourtalesia sp. (aurorae Koehler?).

Таблица 23

Морские ежи – Echinoidea

№ п/п	Вид	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник
a	b	желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	j
		k Отряд Echinothuroida					
		l Семейство Echinothuriidae					
1.	Kamptosoma abyssale Mironov	КК	6090–6235	”В”(2)	4374	n-w с-з То, Ио IN	1 Миронов, 1971
		k Отряд Spatangoida					
		1 l Семейство Holasteridae					
2.	Rhodocystis rosea (Agassiz)	С-з котл То	6096	”В”(1)	2600	IN То, Ио, Ао	1 Миронов, 1975
		ПР PR	6290–6314	DM ”ДМ”(1)			
		CAY Кайм (Б)	5800–6500	”АК”(1)			
			6800–6850	”АК”(2)			
		Кайм (О)	5900–6300	”АК”(1)			
			6300–6780	”АК”(2)			
		l Семейство Pourtalesiidae					
3.	Ceratophysa ceratopyga valvaecristata Mironov	Ал AL	6296–6328	”В”(1)	4200	n с То	1 Миронов, 1976
		2 С-в котл То	6272–6282	”В”(1)			
4.	Echinosigra amphora amphora Mironov	2 С-в котл То	6272–6282	”В”(1)	5035	n-w с-з То	1 Миронов, 1974
5.	E.a. indica Mironov	Яв Y	6433–6850	”В”(2)	–	–	То же 2 1
6.	E. amphora ssp.?	Пал PL	7000–7170	”В”(1)			Беляев 3, Миронов, 1977а 1
7.	Echinosigra sp.	1 С-з котл То	6076	”В”(1)			Миронов, личное сообщение 4
8.	Pourtalesia heptneri Mironov	Бан B	7130–7340	”Gal”(1) ”В”(2)	–	–	Madsen, 1956b*; 1 Миронов, 1978б
9.	Pourtalesia sp. (aff. debilis Koehler)	Хьорт	6100–6650	DM ”ДМ”(2)	4664	ANT Ант (То, Ао)	1 Миронов, 1974, 1978а
		ЮС SS	6052–6150	”АК”(1)			
		м Скотия SC	5650–6070	”АК”(1)			
10.	Pourtalesia sp.	Япон JAP	6156–6207	”В”(1)			1 Миронов, 1976
		l Семейство Urechinidae					
11.	Pilematecinus belyaevi Mironov	CAY Кайм (Б)	5800–6500	”АК”(1)	–	–	1 Миронов, 1975
		Кайм (О)	6740–6780	”АК”(1)			

*Впервые этот вид указан Мадсеном под названием Pourtalesia sp. (aurorae Koehler?).

TABLE 24. POGONPHORA

Таблица 24

Погонофоры – Pogonophora

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости, i	
1	2	3	4	5	6	7	8
		K Семейство Lamellisabellidae					
1.	Lamellisabella johanssoni Ivanov	JAP Япон	6156–6207	"В"(1)	–	–	Ivanov, 1957; Иванов, 1960б 1
		K Семейство Oligobrachiidae					
2.	Birsteinia sp.*	КК	9000–9050	"В"(1)	–	–	Иванов, 1960б 1
		K Семейство Polybrachiidae					
3.	Cyclobrachia auriculata Ivanov	Буг BG	7974–8006	"В"(1)	–	–	Иванов, 1960а, б 1
4.	Diplobrahia japonica Ivanov	Ал AL JAP Япон ИБ IB	7200 6600–7587 8800–8830	"В"(1) "В"(3) "В"(1)	4260	n с То	Иванов, 1960а, б; 1 Иванов, Гуреева, 1973 1 2
5.	Heptabrachia abyssicola Ivanov	КК	6475–8100	"В"(2)	–	–	Иванов, 1952, 1960б 1
6.	H. subtilis Ivanov	ИБ IB	9715–9735	"В"(1)	–	–	Ivanov, 1957; Иванов, 1960б 1
7.	Polybrachia choanata Ivanov et Gureeva	КК JAP Япон	9000–9050 6600–6670	"В"(1) "В"(1)	–	–	Иванов, 1960б; Иванов, Гуреева, 1973 1 1 2
8.	Polybrachia sp. G* Ivanov	КК	8100	"В"(1)	–	–	Иванов, 1960б 1
9.	Polybrachia sp.*	P Пер	6324–6328	"Vema"(1)	5727	P Пер	Иванов, 1969; Ivanov, 1971 1
10.	Zenkevitchiana longissima Ivanov	КК	8330–9500	"В"(3)	4840	КК	Ivanov, 1957; Иванов, 1960б 1
11.	Polybrachiidae gen. sp.	P Пер	6324–6328	"Vema"(1)	–	–	Иванов, 1969; Ivanov, 1971 1
		K Семейство Sclerolinidae					
12.	Sclerolinum javanicum Ivanov (nom. nudum)	Y Яв	6820–6850	"В"(1)	–	–	3 Беляев, 1966б (Иванов) 1
13.	Sclerolinum sp.*	RYU Рюкю	6810	"В"(1)	–	–	То же 4
		K Семейство Siboglinidae					
14.	Siboglinum caulleryi Ivanov	КК	8100	"В"(1)	22	SEA OF OKHOTSK Охотское м	Ivanov, 1957; Иванов, 1960б 1 1
15.	S. longimanus Ivanov	P Пер	6324–6328	"Vema"(1)	5727	Пер P	Ivanov, 1971
16.	S. pusillum Ivanov	AL Ал	6960–6980	"В"(2)	1950	n с То	Иванов, Гуреева, 1973 1 2
17.	Siboglinum sp. II Ivanov	КК	9000–9050	"В"(1)	–	–	Иванов, 1960б 1
18.	Siboglinum sp. IV Ivanov*	КК	8100	"В"(1)	–	–	То же 3
19.	Siboglinum sp. VI Ivanov*	КК	9000–9050	"В"(1)	–	–	"

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Key:

a. No. in order
b. Species
c. Finding at below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
k. Family

Column 8
1. Ivanov
2. Gureyeva
3. Beliaev
4. The same

* The types of Pogonophora cited in the letter and number designations or only from the genus names, due to the insufficient materials are indicated in the works of A. V. Ivanov [1960b, 1969; Ivanov, 1971] without descriptions or only with a description of the pipe grab. However, based on the structure of the pipe grabs, Ivanov believes that all of them belong to different new species that differ from those previously described.

Таблица 24 (продолжение)

1	2	3	4	5	6	7	8
20.	Siboglinum sp. VIII Ivanov*	Буг BG	7974–8006	"B"(1)	–	–	"
21.	Siboglinum sp. IX Ivanov*	Буг BG	7974–8006	"B"(1)	–	–	"
22.	Siboglinum sp. n. Ivanov*	Ал AL	6410–6757	"B"(1)	–	–	3 / Беляев, 1966б (Иванов)
23.	Siboglinum sp. n. Ivanov*	JAP Япон	7565–7587	"B"(1)	–	–	То же 4
24.	Siboglinum sp. n. Ivanov*	Яв Y	6841	"B"(1)	–	–	"
25.	Siboglinum sp.*	P Пер	6324–6328	"Vema"(1)	–	–	/ Иванов, 1969; Ivanov, 1971
26.	Siboglinum sp.*	P Пер	6324–6328	"Vema"(1)	5751	Пер	То же 4
			K Семейство Spirobrachiidae				
27.	Spirobrachia beklemischevi Ivanov	КК	9000–9050	"B"(1)	–	–	/ Ivanov, 1957; Иванов, 1960б 2
28.	S. leospira Gureeva	SS ЮС	8004–8186	"AK"(1)	–	–	Гуреева, 1975
	closenot defined	BG	K Семейство?				/
29.	Pogonophora, ближе не определенные (Gen. sp. J Ivanov*)	Буг	7974–8006	"B"(1)	–	–	Иванов, 1960б

*Виды погонофор, приведенные под буквенными и цифровыми обозначениями или только с родовыми названиями, из-за недостаточности собранных материалов указаны в работах А.В. Иванова [1960б, 1969; Ivanov, 1971] без описаний или только с описанием трубок. Однако, судя по строению трубок, Иванов считает, что все они относятся к различным новым видам, отличающимся от описанных ранее.

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TABLE 25. ASCIDIAE

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
l. family

Column d
1. Northwest trough

Column i
1. Tasman Sea; southeast Pacific Ocean

Column j
1. Beliaev
2. Mironov
3. Vinogradova
4. The same
5. Zenkevitch

Additionally, single Ascidiae that were found closer in the trenches were not defined: Al, 6,296-7246 m, V (3); KK, 6,090-6,135 m, V (1); Volc, 6,330-6,785 m, V (2); Ryukyu, 6,660-6,670 m, V (1); P, 6,040-6,328 m, Vema (1); AK (2); northwest To trough, 6,051-6,127 m, V (4); northwest To trough, 6,065 m, V (1); SS, 6,052-8,116 m, AK (4); SC, 5,650-6,070 m, AK (1); R, 6,330-6430 m, AK (1); on the photographs of the floor obtained in the New Hebrides trench there were also findings 6,758-6,776 m, SpFB (1-P) [per: Beliaev, 1966b, 1972; Vinogradova, 1974; Vinogradova et al., 1974; Lemche et al, 1976; Beliaev, Mironov, 1977a].

*The photograph of this Ascidia was published in the book Nauchno-issledovatelskoye sudno Vityaz' i ego ekspeditsii [Research Vessel Vityaz and Its Expeditions], [1983, Table XII, 8,9].

Таблица 25

Асцидии – Ascidiae

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
		ℓ Семейство Corellidae					
1.	? Corellidae sp. sp.	НБ NB НГ NH	7057–7075 6758–6776	"SpFB"(1–Ф) "SpFB"(1–Ф)			Lemche et al., 1976
		ℓ Семейство Hexacrobylidae					
2.	Hexacrobylus sp.	Фил PLP	7420–7880	"B"(1)			Беляев 1, Миронов 2, 1977а (Виноградова) 3
3.	Hexacrobylidae gen. et sp. n.	VOLC Волк	6330	"B"(1)	5070	n с То	То же 4
		ℓ Семейство Octacnemidae					
4.	Octacnemus sp.	КК	8185–8400	"B"(1)		REGION	Виноградова* 3
5.	Situla pelliculosa Vinogradova	КК	7265–8430	"B"(3)	5035	Район КК	Виноградова, 1969а 3
		ℓ Семейство Pyuridae					
6.	Culeolus murrayi Herdman	JAP Япон	6156–6207	"B"(1)	3350	n с То, Ант. ANT	Виноградова, 1970 3
7.	C. robustus Vinogradova	КК	7265–7295	"B"(1)	–		То же 4
8.	C. tenuis Vinogradova	JAP Япон 1 С-з котл То 2 С-в котл То	6156–6207 6096 6272–6282	"B"(1) "B"(1) "B"(1)	5027	NW с-з То	"
9.	Culeolus sp. sp.	КК JAP Япон	7210–8015 6380	"B"(2) "B"(1)			5 Зенкевич и др., 1955; Беляев, 1966б (Виноградова) 3
		ℓ Семейство Styelidae					
10.	Cnemidocarpa bythia (Herdman)	Кер	6180–7000	"Gal"(2)	4400	Тасманово м; ю–в Ио	Millar, 1959

Кроме того, не определенные ближе одиночные асцидии были найдены в желобах: Ал, 6296–7246 м, "B"(3); КК, 6090–6135 м, "B"(1); Волк, 6330–6785 м, "B"(2); Рюкю, 6660–6670 м, "B"(1); Пер, 6040–6328 м, "Vema"(1), "АК"(2); С-з котл То, 6051–6127 м, "B"(4); С-в котл То, 6065 м, "B"(1); ЮС, 6052–8116 м, "АК"(4); м Скотия, 5650–6070 м, "АК"(1); Ром, 6330–6430 м, "АК"(1); обнаружены также на фотографиях дна, полученных в НГ желобе, 6758–6776 м, "SpFB"(1–Ф) [по: Беляев, 1966б, 1972; Виноградова, 1974; Виноградова и др., 1974; Lemche et al., 1976; Беляев, Миронов, 1977а].

*Фотография этой асцидии опубликована в книге «Научно-исследовательское судно "Витязь" и его экспедиции» [1983, табл. XII, *8*, *9*].

TABLE 26. OSTEICHTHYES

Key:

a. No. in order
b. Species
c. Finding below 6,000 m
d. Trench or trough
e. Depth, m
f. Research vessel (number of findings)
g. Dissemination at shallower depths
h. Minimum depth, m
i. Region of encounter
j. Source
l. Family
m. Order

Column 7
1. Yucatan trough and region of Puerto Rico trench

Column 8
1. Shcherbachev, Tsinovskiy
2. Nielsen
3. Andriashev
4. Rass
5. Personal report

*The description of this species by Nielsen for the Puerto Rico trench indicates only one of his findings, at depth 8,370 m. Fish from this depth were initially indicated [Staiger, 1972] as Bassogiga profundissimus. However, there are several known reports that the fish from the genus Bassogigas were also caught in the Puerto Rico trench at depth 7,965 m [Anonym, 1970a,b,c; the report of Prof. G. Voss in a March 1, 1971 letter to the author]. It remains unknown if this is the same finding with revision in the work of Staiger of the catch depth, or a second finding of the species from the family Ophidiidae.

Таблица 26

Рыбы – Osteichthyes

№ п/п a	Вид b	Нахождение глубже 6000 м c			Распространение на меньших глубинах g		Источник j
		желоб или котловина d	глубина, м e	э/с (число нахождений) f	минимальная глубина, м h	район встречаемости i	
1	2	3	4	5	6	7	8
	m Отряд Gadiformes						
	l Семейство Macrouridae 1						
1.	Coryphaenoides sp.	С-з котл То	6180	"SM"(1)			Okutani, 1982
	l Семейство Ophidiidae						
2.	Abyssobrotula galatheae Nielsen	ПР PR	8370	"JEP"(1)	2330	То, Ио, Ао	Staiger, 1972; Nielsen, 1977*; Щербачев, Циновский, 1980 1
		JAP Япон	6480–6640	"B"(1)			
3.	Holcomycteronus profundissimus (Roule)	TROUGH Котл	6035	"PrAl"(1)	5180	То, Ио, Ао	Roule, 1913; Bruun, 1953b; Nybelin, 1957; Nielsen, 1964, 1980; Stein, 1978
		ЗелМ ZM					
		Яв Y	7160	"Gal"(1)			
4.	Leucicorus atlanticus Nielsen	CAY Кайм	5800–6800	"AK"(5)	4580	1 Юкатанская котловина и район желоба ПР	Нильсен, 1975 2
	m Отряд Scorpaeniformes						
	l Семейство Liparidae						
5.	Careproctus (Pseudoliparis) amblystomopsis Andriash.	КК	7210–7230	"B"(1)	–	–	Андрияшев, 1955; 3
		Япон JAP	6156–7587	"B"(2)			Расс, 1958, 1974 4
6.	C. (Pseudoliparis) sp. n. Andriashev	JAP Япон	7565–7587	"B"(1)	–	–	3 Андрияшев, личное 5 сообщение; Расс, 1958, 1974 4
7.	Notoliparis kermadecensis (Nielsen)	kerm Керм	6660–6770	"Gal"(1)	–	–	Nielsen, 1964; Андрияшев, 1975 3

*При описании этого вида Нильсен для желоба Пуэрто-Рико указывает лишь одно его нахождение – на глубине 8370 м. Первоначально рыба с этой глубины была указана [Staiger, 1972] как Bassogigas profundissimus. Известно, однако, несколько сообщений о том, что рыба из рода Bassogigas была поймана в желобе Пуэрто-Рико также на глубине 7965 м [Anonym, 1970a, b, c; сообщение проф. G. Voss в письме автору от 1.III.1971 г.]. Остается неизвестным, имеется ли в виду одно и то же нахождение с уточнением в работе Стайгера глубины лова, или речь идет о втором нахождении вида из семейства Ophidiidae.

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